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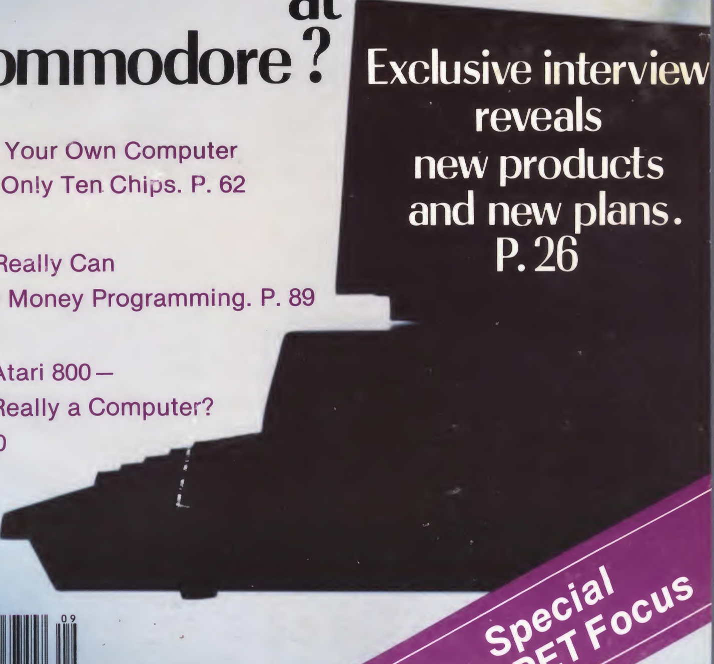
MICROCOMPUTING T.M.

A Revolution at Commodore?

Exclusive interview reveals new products and new plans. P. 26



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Special PET Focus

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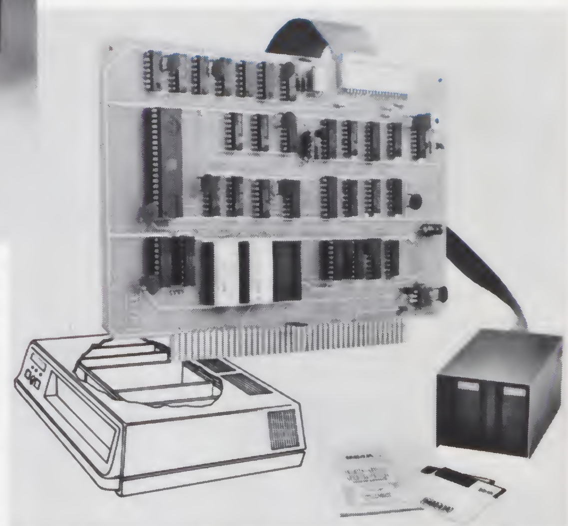
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Versatile Mother Board, Full-Feature Prototyping Boards 15

Printed wiring is easily soldered tin-lead plating. Substrates are glass-epoxy. Prototyping cards provide for power regulators and distributed capacitor bypassing, accommodate 14-, 16-, 24- and 40-pin DIP sockets. Prototyping boards include bus connectors, other connectors and sockets are optional.

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SS-50 BUS CARD — accommodates 34- and 50-pin ribbon connectors on top edge, 10-pin Molex connector on side edge. Price: $24.95.

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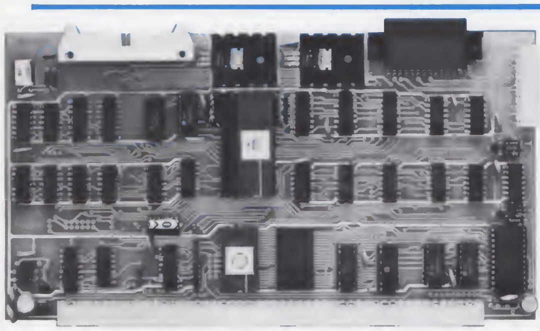

The SBC/9™. A "10" By Any Measure. 13

The Percom SBC/9™ is an SS-50 bus compatible, stand-alone Single-Board Computer. Configured for the 6809 microprocessor, the SBC/9™ also accommodates a 6802 without any modification. You can have state-of-the-art capability of the '09. Or put to work the enormous selection of 6800-coded programs that run on the '02.

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- Total compatibility with the SS-50 bus. Requires no changes to the motherboard, memory or I/O.
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- Includes 1-Kbyte of static RAM.
- Costs only $199.95 with PSYMON™ and comprehensive users manual that includes source listing of PSYMON™.

The Electric Window™: Instant, Real-Time Video Display Control 16

Memory residency and outstanding software control of display format and characters make this SS-50 bus VDC card an exceptional value at only $249.95. Other features:

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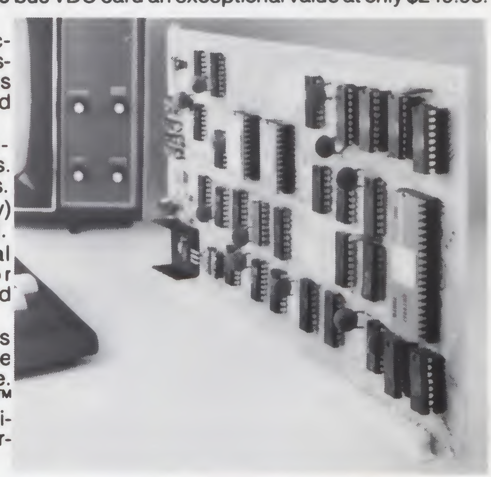
- Well-formed, easy-to-read 7x12-dot characters. True baseline descenders.
- Character-store (display) memory included on card.
- Provision for optional character generator EPROM for user defined symbols.
- Comprehensive users manual includes source listing of Driver software. Driver — called WINDEX™ — is available on mini-diskette through the Percom Users Group.



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Wayne Green

PUBLISHER'S REMARKS

One of the new Tandy computer centers is now open in Cologne, West Germany. The store is well-decorated, demonstrates several systems operating but lacks ambience as yet.

This year's Consumer Electronics Show (CES) in Chicago featured acres of incredibly expensive exhibits. Can they really pay for themselves? Fortunately, the attendance was down considerably, so it was much easier to move through the place and to get a word in edgewise with the exhibitors, who in past years have been too busy to talk.

The exhibitors of this CES display sell signs run by a TRS-80 system.

I Think Bally Is Wrong

I could hardly escape the deluge of microprocessor toys at the Consumer Electronics Show (CES) in Chicago—they were everywhere. Bally displayed the largest toy exhibit, which featured a maze of microcomputer toys set up for the attenders to operate. Their games—flashy, and probably addictive—included baseball, with runners woodenly hopping around the screen in full color; basketball; football; and every other game of note.

I asked their software mogul if the company had any interest in educational programs or business software. No, they were programming in-house, but might be interested in game programs if they had plenty of action on the screen, nothing more. I nodded and walked on.

Bally, like Atari, has made quite a name in games, so I can understand their preoccupation with them. But I wonder if their background in arcade-game sales has really prepared them for the consumer computer market. Presumably, they have made some surveys to explore the market for high-ticket game computers. . . and received a go-ahead signal.

Two thoughts came to my mind with regards to the strength of the high-ticket game market. First, there is the growing softness of the consumer market for almost anything. Even a brief reading of the *Wall Street Journal* should convince you that dealers are cutting inventories and that sales of expensive gadgets are way down. *WSJ* recently featured the retailer retrenching for this coming Christmas season.

In case you think that the recession is all media hype, just ask a few retailers how high-ticket items, such as home and auto stereo systems, video recorders and game computers, are doing. Disastrously in recent weeks. A few of the retailers I talk with have ham departments, which are all that have kept them financially afloat. The hams are buying, but few other people are.

While the general public is staying away from expensive toys, the market for microcomputers is doing surprisingly well. The pressures for cutting costs in business have driven many businessmen to seriously consider buying a

The TI-99/4 is on display in department stores in much of Europe. However, since it lacks competition in this environment, will it sell? The price is high, and the accessory and software support is minimal.

The Casio FX-9000P was premiered at CES. It features a good graphics display system with 256 × 128 dots and slots for plugging in four memory packages which can be 4K ROM or RAM (C/MOS with power backup) or 16K dynamic RAM. It comes with BASIC, with a 16K expanded BASIC package promised. Accessories will include a cassette interface, printer interface, clock/calendar and an RS-232 interface.

At the larger Kaufhof department stores in West Germany, the Commodore systems were up against the TI-99/4 and priced substantially lower. The PET/CBM systems were usually occupied with kids writing and checking programs, while the TI systems sat idle.

I'm on the right, talking with Mr. Man and Mr. Wong, both from Hong Kong and working for EACA.

computer. They are far more receptive to buying a $5000 system than a $25,000 minicomputer—a development that Radio Shack is exploiting nicely.

Schools are also getting into the act. A number of schools have consulted me as to their best bet in systems. Several manufacturers are making especially attractive deals for schools that purchase bulk lots of computers for their classes. I think we will be seeing the computer-education market growing rapidly. Teachers may be afraid of computers, but they can't fight them too hard because even the most reactionary of them recognizes that there is a computer in everyone's future.

The Drug Syndrome

The second concept that developed in my mind after I witnessed the concentration of game computers at CES had to do with an assessment of the value to the world of this type of high-price toy consumption. A recent television program about the serious problem in Germany with kids on heroin brought the idea into focus.

Pathetically few people spend much of their time doing anything constructive toward improving the world. I'm thinking in terms of being creative, teaching, pioneering, etc. On the other hand, we have many, if not most, people just taking a ride on the few constructive people—perhaps fighting them at times.

Sure, we need some entertainment, but I think this has gotten away from us. There are millions of people who are all wrapped up in baseball and other games that are of little long-term significance. Add to that 90 percent or more of the people who are TV-watchers, movie-goers and bar patrons, and you'll find that most of us are taking a ride, contributing little to the world. Can you see a parallel line between the rationalization of the drug dealers who shrug their shoulders and explain their business as meeting a need of the people and those who provide us with football and television game shows?

Perhaps I am unfair when I think of these

This is the Video Genie System EG-3003—also known as the TRZ-80 and the Dick Smith 80. It is made in Hong Kong by EACA and is going to be distributed as the PMC-80 in the U.S. by Personal Micro Computers. It is compatible with the TRS-80 software, so this should give it a big boost in sales in this country. It is doing well in Europe already. This photo was taken in Amstelveen, Netherlands, the site of their European offices.

Another newcomer at the Paris show was this Victor Lambda Compute-A-Color computer.

At the Paris Micro Expo the Small Business Systems SBS-8000 was set up and running with a data base management program, a dual floppy disk and printer.

The NASCOM unit from Britain is doing well in Europe. They had explored the possibility of exporting to the U.S., but decided to wait until they had more strength in Europe before expanding to this country.

The DAI from Holland is receiving a lot of attention in Europe. It is a flexible system and particularly easy to program. After a few minutes at the computer, Sherry was generating graphics to spell out words. If some firm decides to have a go at importing this system, I think they might be able to do well.

This is the low-end Sharp system. Note the remarkable similarity of the keyboard to the PET! Also the graphics. Hmmm, not all micro technology is being generated in Japan these days. The same graphics are on the larger Sharp unit, which is remarkably similar to the Commodore CBM.

things as I walk through a store filled with electronic toys. Video recorders *can* be used for beneficial projects, and there *are* some interesting and valuable television programs. But what is our excuse for a computer that plays games—period?

Many people in our country could land better jobs if they were being trained for them. Computers could help with this via simulations. Anyone who really wants to help inch the world ahead can do so by writing a good computer educational or business program or an article for a magazine such as this.

Most microcomputer manufacturers have come to recognize that while just about everyone who buys a system will want some games to go with it, the educational or business uses are usually the determining factor in the sale. While it is valuable to have games available for computers, they should not be counted on as the primary sales tool.

In school environments, where perhaps one-third of the microcomputer sales will occur during the next year, games are even less important. Too many games reduce the value of the computers to the schools.

Atari seems to be aware of the importance of supporting their system with more than flashy games, so they may have a better chance at coming through the next year or two. Their weakness at present is their lack of software. This is a serious weakness, and I've talked with dealers who are dropping the Atari line because the system is not adequately software supported. The space game that comes with it is a corker, but it doesn't get people to whip out a kilobuck. They want more than a race through space for that much money.

Quasar

A surprise exhibit at CES was a new computer system by Quasar. This, as well as Panasonic, is one of the branches of Matsushita, a very large firm. The Quasar computer is expected to have a strong showing before the end of this year, and expectations are for the sale of one million systems during 1981. Frankly, having looked at the system, I think they can make it with the right pricing and software support.

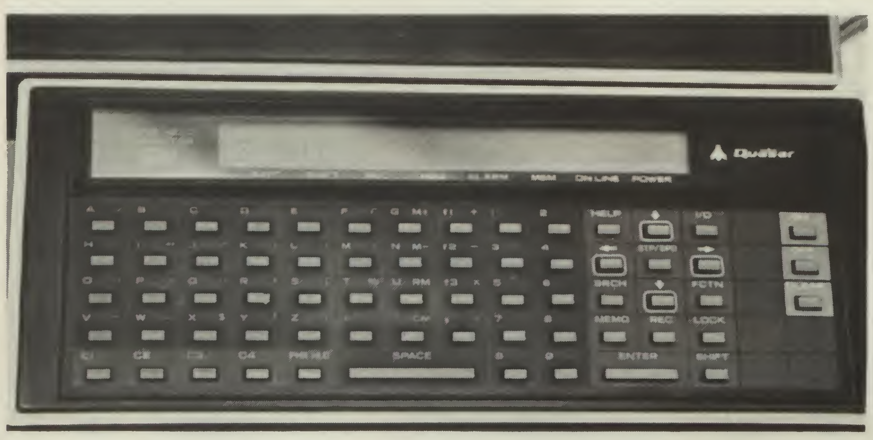
The Quasar computer is small enough to fit into your pocket, carry in a briefcase or connect to the telephone via a small modem. Thus, with some advance in telephone/computer communications, we will be able to access any of the data services or our own home or office system from just about anywhere using a Quasar. This means that most of the estimated 750,000 microcomputer owners will be good prospects for another system—a portable one.

Other Japanese Products

NEC (Nippon Electronic Company) displayed their system at NCC, watching carefully for the response of the audience and dealers. Their system is competitive with Apple. A decision on whether or not to earnestly get into business in the U.S. is expected within the next few weeks. NEC has done well in the incredibly competitive Japanese market, so it seems likely that they will bring some of their marketing expertise over with their system. Japan has stores devoted to the NEC system, with many of the stores set up to accommodate a dozen visitors to test the system. They give courses in using the system and in general provide a high degree of customer and dealer support. The NEC system has excellent high-resolution color graphics, which could greatly appeal to potential U.S. customers.

Sharp has begun a major effort to introduce their computer in Europe, so we should expect that this will soon spread to the U.S. They, too, have a competitive system and may be pushing hard.

Of course, our own manufacturers are not sitting still. Commodore has recently made a



A prototype of the Quasar (Matsushita) Hand Held Computer (HHC), one of four said to be in the country, was on display at the Chicago CES.

By plugging in peripheral units you can expand the HHC to provide an easily portable computer system, which includes RAM and ROM units, a modem, cassette interface unit and even a small alphanumeric printer. The whole works will fit into an attache case.

complete change in their marketing staff. Ads are beginning to appear, for the first time, really, since the introduction of the product over two years ago. They have some new and competitive systems that will be coming this fall. We'll be seeing a $300 or $400 color system (read our interview with Commodore on page 26).

Tandy has at least one new product announcement in the works for later this year. I expect we'll see both a color system and a low-cost system that uses a TV set for a monitor.

Software

In the profusion of new hardware being announced, don't overlook the lack of enough software. As the dust settles and dealers hunker down for the long haul of selling all this fine hardware, they are going to be insisting on software to be made to keep up with the hardware production.

Boney Foney

JS&A comes out with some excellent products every now and then. They also come out with some bummers, so you have to be careful when reading Joe Sugarman's compelling copy. He is a master at writing mail-order advertising.

Despite its extremely persuasive advertising copy, the Bone Fone didn't make sense to me. As a former designer and manufacturer of high-fidelity loud speaker enclosures, I am not easily gulled when it comes to hi-fi claims. The idea of an AM/FM receiver with tiny speakers in a contraption that drapes over the shoulders being able to communicate hi-fi to the ears (or body) was unacceptable.

Anything (almost) is possible, so I reserved final judgment of the Bone Fone until I experienced it myself. I had the chance at the Chicago Consumer Electronics Show, where I tried on a unit and heard what I expected to hear—poor sound.

The July *Consumer Reports* criticized not only the poor sound of the Bone Fone, but also the poor design of the radio, which has bad selectivity, and the awkward position of the tuning controls.

If you want to tune into FM radio while you jog or walk, I suggest the Panasonic FM-20 combination headset and FM stereo radio. It's heavier than the Sony TPS-L2 cassette player, but it is entirely contained in the headset, and the fidelity is superb.

I wish that some American manufacturer would come up with an innovative design, but these days we seem to be importing technology from Japan instead of exporting it. Until we can get more technicians and engineers than they have in Japan, I think we are going to stay behind and, as a result, lose billions of dollars in high technology equipment sales. We'll get the technicians and engineers we need when we revive amateur radio. The lack of growth in amateur radio in the last 15 years has led to a dramatic decline in the number of technicians in this country.

Barry Goes West

Sadly I report that John Barry, the managing editor of *KM* since October 1977, has moved to Silicon Glitch. Having never been to California before, John, I'm sure, didn't realize what he was getting into. Show me a New Hampshirite in California, and I'll show you a very homesick person.

John moved out—possibly as a humanitarian gesture—to try to help save a floundering, directionless publication. We wish him a modest amount of luck and are saving a spot for him when he realizes that it's better to watch haircuts in Peterborough than to sit in traffic in Redwood City.

No offense, Silicon Glutters, but every time I stop by to see what is going on in Sunnyvale and Cupertino, I marvel at the patience you chaps have developed to live with the traffic. The only thing slowing us down in New Hampshire is the police radar—unless you have a radar detector. Up here, it takes half an hour to travel 30 miles. In the Land of the Permanent Haze, if you're going 30 miles, you pack a lunch and take extra water for the car radiator.

There are positive things to say about the flood plain south of San Francisco. It's a first-rate area for education. By packing extension course materials in your car, you can earn an advanced degree just studying while waiting for the traffic lights to change. And where else would you expect to find psychiatrists and lung cancer clinics with 24-hour service and flashing neon lights?

OUTPUT FROM INSTANT SOFTWARE

Sherry Smythe

A recent study by one of the largest publishers in the country listed Instant Software as one of the top companies in both sales and customer satisfaction. This was mighty good news to the ISI crew, which has worked hard to earn such recognition. Today no other program publisher has the facilities or the distribution to match ISI.

It has been a long pull for ISI to get everything working. It's taken over two years to develop the ability to duplicate cassettes with virtually no customer problems, to get a system working smoothly for evaluating programs, to write the documentation and to package the whole works. Not until the supply of packaged programs was sufficient could the distribution system be attempted, for without a good supply or programs, reps are unable to make enough money to stay in business. It's all come together now, and the business is growing every month. It is most gratifying to get calls from dealers who are happily making money with ISI programs—no customer gripes, only returning customers looking for more software.

ISI's function is very important for the support of the microcomputer industry. Even the hardest heads in the business are beginning to realize that no systems manufacturer can hope to provide enough software for his system to match that provided by independent suppliers. Thus, if independent suppliers do not receive cooperation from the manufacturer, they will obviously work with the systems manufacturers who do cooperate. This will leave the unsupported system behind in short order.

More than one system has been raked over the coals in the popular press. Articles in *Money, Fortune* and other publications have put down systems with little software support and little prospect of such. Initially every manufacturer wants to be the sole supplier of *everything* for his system. Why should anyone else make money by selling things he would like to sell?

The first firm in the field, Mits, went through that reaction, which is one reason why they are practically unknown in the field today. They went so far as to drop computer stores that dared to handle non-Mits products. The result was that they lost just about all of their good dealers. The lack of serious encouragement for outside software support will, I predict, be one of the most powerful factors in killing off some of the big names that have recently entered in the microcomputer field.

Bonanza for Programmers

Those firms recognizing the importance of quickly getting software support for their systems have little choice but to turn to the larger software houses (such as ISI). They need hundreds, not dozens, of programs if they are going

to be competitive. This is going to turn out to be a bonanza for programmers because usually large firms place an order for a minimum of 10,000 of each program. The software house then translates existing and proven programs for the new system—not a difficult procedure. This generally means a minimum royalty payment of $8000, which is a nice start. Some manufacturers are even talking about ordering 15,000 units of each program package on their first order (around $12,000 in royalties is possible; higher-priced programs result in substantially more).

This is going to be difficult for the mom and pop software publishers and for authors who deal with other than the major publishers. Small publishers don't have the distribution or the advertising to support programs. They also lack the investment to deal with large systems manufacturers.

ISI is looking to publish more programs, particularly business-, educational-, scientific- and utility-type programs—and games, if they are awfully good. ISI still needs more people due to expansion. We estimate that ISI will be doubling in size at least every six months, so that means more and more career opportunities.

We need programmers to translate programs from one system to another. If you have a TRS-80 that can talk to a Heath, a TI-99/4 or another system, please let me know. Some of you may be able to do this contract work at home, but you must be able to finish tasks you start. Most of this work, however, will be done in the ISI labs, using information and equipment supplied by the contract firms.

If you have any programs that might translate into money, perhaps it is time to send for information from ISI on submitting them. Write to Instant Software, Peterborough, NH 03458.

Robert W. Baker

PET-POURRI

Disk Programming Tips

If you have a 2040 Disk Drive on your PET, you can do a number of undocumented tasks with disk files. Once you know more about the internal formats of the disk directory and disk files, a whole new realm of possibilities awaits. I've been experimenting, and would like to share what I've found so far.

First, for those unfamiliar with disks and disk formats, I'll define a few terms and ideas.

Each diskette stores data in 256-byte data blocks, which are referred to as sectors. The data blocks are recorded sequentially around the disk, forming concentric tracks. A diskette recorded on a 2040 drive has 35 tracks, numbered 1 through 35. The number of sectors recorded on each track varies, due to the changing circumference of the tracks. A total of 690 blocks are available on each 2040 disk (Table 1).

Any data block on a disk can then be addressed or referenced by its track and sector numbers. You should remember, however, that this disk format is only for the Commodore 2040 disks. Other computer systems, or even other disk drives for the PET, may use different disk formats and will not be compatible with the PET 2040 disks.

Now that you know a little more about a disk, let's see how the 2040 Disk Operating System (DOS 2.0) knows where files are stored on the disk, how long the files are and what data blocks are being used.

Each diskette initialized by DOS has one system file on track 18 that it maintains for its own use. This track contains the block availability map (BAM), the diskette name and ID and the file directory. The BAM keeps track of what blocks are being used or were found to be defective by a validate command. The diskette name and ID are those assigned to the disk when it was formatted. The file directory contains the file name, file type, starting track and sector and number of blocks used for each file on the disk.

Since most files are longer than 256 bytes, the first two bytes of each data block contain the track and sector numbers of the next block in the file. If the first byte of a data block is zero, it indicates this is the last block of the file. The second byte will then give the number of bytes of this sector that make up the end of the file. This linkage method is used for all file types, including the system file on track 18.

The first sector of the system file on track 18 is used for the BAM and the disk name/ID. The format of track 18, sector 0, is as follows:

2 bytes = link to next track and sector, where the directory starts

2 bytes = $4100 value as system flag for BAM (?)

140 bytes = BAM table with four bytes per track. The first byte indicates the number of free blocks in the track. The remaining three bytes contain one-bit flags for each block in the track. If a bit is set (1)

Track #	Sector range	Sectors/track
1–17	0–20	21
18–24	0–19	20
25–30	0–17	18
31–35	0–16	17

Table 1.

```
10 REM ------------------------------
20 REM
30 REM   BASIC PROGRAM SYMBOL LIST
40 REM
50 REM       BY ROBERT W. BAKER
60 REM
70 REM ------------------------------
80 :
90 PRINT"⊐"SPC(14)"▚SYMBOL LIST▚▚"
100 REM GET DISK DRIVE# & FILE NAME
110 INPUT"▚DRIVE #    0████";DR$
120 INPUT"▚FILE NAME",FL$
130 DIM SM$(500):SM=0
140 PRINT"⊐SCANNING FILE.....▚▚"
150 REM OPEN DISK ERROR/CONTROL CHNL
160 REM THEN OPEN BASIC PROGRAM AS
170 REM SEQUENTIAL READ FILE...
180 OPEN 15,8,15:GOSUB 890
190 OPEN 5,8,5,DR$+":"+FL$+",P,R"
200 REM CHK FOR ERROR & READ LOAD ADR
210 REM WHICH ARE 1ST 2 BYTES OF FILE
220 GOSUB 890:GOSUB 850
230 REM READ LINK & CHK FOR PRGM END
240 GOSUB 850:IF V+V1=0 THEN 750
250 REM READ LINE NUMBER
260 GOSUB 850:LN=V1+(256*V)
270 REM SCAN BASIC LINE FOR SYMBOLS
280 GOSUB 860
290 IF V=0 THEN 240 : REM END OF LINE
300 IF V<>34 THEN 370
310 REM QUOTE -
320 REM SKIP CHRS TILL NEXT QUOTE
330 REM OR LINE END
340 GOSUB 860:IF V=34 THEN 280
350 IF V>0 THEN 340
360 GOTO 240
370 IF V<>131 THEN 500
380 REM DATA TOKEN-
390 REM SKIP CHRS TILL COLON
400 REM OR LINE END
410 GOSUB 860:IF V=58 THEN 280
420 IF V=0 THEN 240
430 IF V<>34 THEN 410
440 REM IF QUOTE FOUND-
450 REM SKIP TILL NEXT QUOTE
460 REM OR LINE END
470 GOSUB 860:IF V=34 THEN 410
480 IF V>0 THEN 470
490 GOTO 240
500 IF V<>143 THEN 560
510 REM REMARK TOKEN-
520 REM SKIP CHRS TO LINE END
530 GOSUB 860:IF V>0 THEN 530
540 GOTO 240
550 REM CHK FOR VALID SYMBOL
560 IF V<65 OR V>90 THEN 280
570 S$=C$:GOSUB 860
580 IF V<48 OR V>90 THEN 640
590 IF V>57 AND V<65 THEN 640
600 S$=S$+C$
610 GOSUB 860
620 IF V<48 OR V>90 THEN 640
630 IF V<58 OR V>64 THEN 610
640 IF V=36 OR V=37 THEN GOSUB 840
650 IF V=40 THEN S$=S$+"()":GOSUB 860
660 REM SAVE IF NEW SYMBOL
670 Z=SM:IF SM=0 THEN 730
680 FOR X=0 TO SM
690 IF SM$(X)=S$ THEN 290
700 IF S$>SM$(X) THEN NEXT X:GOTO 730
710 Z=X:FOR Y=SM TO Z STEP -1
720 SM$(Y+1)=SM$(Y):NEXT Y
730 SM$(Z)=S$:PRINT S$,
740 SM=SM+1:GOTO 290
750 CLOSE 5:CLOSE 15:OPEN 4,4
760 REM PRINT SYMBOL TABLE IN ORDER
770 PRINT#4,"▚SYMBOL LIST:█ ",FL$
780 PRINT#4
790 FOR X=0 TO SM
800 PRINT#4,SM$(X);SPC(8-LEN(SM$(X)));
810 NEXT X:PRINT#4
820 PRINT"⊐DONE▚▚":CLOSE 4:END
830 REM SUBROUTINES
840 S$=S$+C$:GOTO 860
850 GOSUB 860:V1=V
860 GET#5,C$:GOSUB 890
870 IF C$="" THEN V=0:RETURN
880 V=ASC(C$):RETURN
890 INPUT#15,EN,EM$,ET,ES
900 IF EN=0 THEN RETURN
910 PRINT"⊐▚DISK ERROR"
920 PRINT EN,EM$;ET,ES
930 CLOSE 5:CLOSE 15
```

Listing 1.

the block is available; otherwise, it is used or defective if the bit is clear (0). The bits are marked as follows:

```
00000000  11111100  ...21111
76543210  54321098  ...09876

 first     second    third
 byte      byte      byte
```

16 bytes = disk name (in ASCII)
2 bytes = reverse spaces ($A0)
2 bytes = disk ID
1 bytes = reverse space ($A0)
2 bytes = DOS version that formatted disk

The disk directory normally starts on sector 1 of track 18 and contains one entry for every file on the disk. Each entry consists of 32 bytes as follows:

1 byte = file type flag:
 $00—deleted
 $81—sequential (data) file
 $82—program file
 $83—user file
2 bytes = starting track and sector number
16 bytes = file name
7 bytes = ??? (usually $00)
2 bytes = starting track and sector of new file during REPLACE command
2 bytes = number of blocks in file
2 bytes = ??? (usually $00)

When you write a file to the disk, a directory entry is made with all appropriate values. In addition, each block used by the file is deleted from the BAM by clearing the appropriate bits and adjusting the number of available blocks for each track used.

When you scratch (delete) a file from a disk, the flag is set to zero in the directory and the BAM is updated to indicate the blocks made available. The actual data blocks of the file are not changed in any way when the file is deleted. Also, the directory entry still has the starting track and sector numbers, along with the number of blocks originally in the file.

If you accidentally scratch a file, you can recover the file by resetting the file type flag and reallocating the blocks used by the file. Since you can get the starting track and sector from the directory entry, you only have to read the linked blocks to find what blocks were used by the file.

However, this assumes that no other write operations were performed to the disk after the file was scratched. If you count the blocks linked in the file and compare with the number of blocks indicated in the directory entry, you can verify the file is "probably" still intact. Let me know if you have a simple utility program to provide this function and eliminate all the work. I haven't had the time to do it myself.

The file formats are simple. Sequential data files contain the data stored sequentially, but written by the user program. Each data block contains the two-byte track and sector link followed by 254 bytes of data. Program files contain a two-byte load address following the block link on the first block of the file. The program is then stored exactly as in memory, whether a machine-language program or a BASIC program.

The first 252 bytes of the program are stored in the first block, and each following block contains another 254 bytes of the program. Remember that BASIC programs are stored exactly as stored in memory with BASIC keywords replaced by one-byte tokens. Each BASIC line contains a two-byte link, a two-byte line number (address format lo/hi), the BASIC line and an end of line flag (1-byte = 0). The end of the program will be indicated by a zero link.

Not mentioned in the 2040 manuals is that program files can be opened and read or written by a user program the same as sequential data files. This lets you read BASIC programs as data to another program or have a program write a BASIC program.

Listing 1 is a sample program that illustrates one simple application of this capability. The program will print or display a list of variables used in a BASIC program. It uses the GET$ command to read the disk file byte by byte. Therefore, it is rather slow but still quite effective. This lets you write many utility programs formerly done by complicated machine-language routines, or not even possible. With the ever-changing ROM operating systems, writing utilities in BASIC will also ensure they will always work.

Just think about the endless possibilities: a real BASIC program merge capability, a variable cross-reference listing, BASIC subroutine libraries that can be added to any program and "overlays" for part of BASIC programs.

If you come up with any good ideas or a program you'd like to share, please let me know.

```
[illegible] SYM LIST

C$      DR$     EM$     EN      ES
ET      FL$     LN      S$      SM
SM$()   V       V1      X       Y
Z
```

Table 2. Symbol list.

Product Reviews

I recently received several sample programs from Copytronics in the Netherlands. They were recently listed as a supplier of programs written for the 3G Light Pen, but I warned that I had not tried any of their software.

Well, their 3G Light Pen Demo program is not overly impressive, and all the instructions are in Dutch. With a $17.50 price tag, it doesn't seem very worthwhile.

Copytronics is also supplying other software for the PET from the PET Users Group in their area. Each program sells for $12.50 and is sent by air mail.

Some of the sample programs are simple, such as a horse race with graphics. Other programs are similar to those available from U.S. suppliers and authors at a much lower cost. In addition, most of their programs appear to be written for the original 8K PET with the old ROMs and would not be usable with the newer ROMs.

Axiom Corp. has announced another line of small low-cost printers, which will eventually include a PET-compatible version. The IMP series of printers are all 7 × 7 dot-matrix impact printers with 80, 96 and 132 columns per line. With bidirectional printing, the print speed is one line per second, and double-size characters are available for enhanced printing.

The most incredible feature is the printer's size—it is only 3.5 inches high. I've been told the PET model will include the entire PET graphics set, but that the printing controls will probably be quite different from the previous electrostatic printers (EX-801 and EX-802).

Recently, I've received requests from readers to provide copies of programs that appeared in this column on cassette tape. If you really hate to type that much, I'll be happy to supply copies of any of my programs that appear in this column for $2 each, postpaid. As always, please direct all requests and any information for this column to my home address and not through the magazine: Robert W. Baker, 15 Windsor Drive, Atco, NJ 08004.

I've been trying to test each product before including a review. In addition, I can test any given product on all PET models, with any ROM operating system and with any combination of Commodore equipment. This includes the new 80-column PET, Disk BASIC and the new Disk Operating System (DOS 2). If a given product or program depends on another configuration (such as Computhink disks), I cannot give an honest review with my current PET systems.

Otherwise, I'll continue reviewing products received and include programming tips as space permits. If you have any information you'd like to share, please write, but include an SASE if you expect a response.

Thirteen for the Price of One

If you're with a group that is using several computers at the same location, here's a peripheral method that will let you share one printer and one disk drive with as many as 13 PETs. Furthermore, it'll cost you nothing more than the price of the extra cables.

Each user will have access to the peripheral as though it were connected exclusively to his computer, as long as no more than one user at a time accesses the devices.

First, connect one PET to the disk drive, using the standard PET/IEEE cable.

Second, connect the IEEE/IEEE cable to the printer and the extension socket on the PET/IEEE cable.

Third, using standard PET/IEEE cables, connect the remaining PETs into any convenient extension socket on any of the other cables.

That's it. Turn on your PETs and the peripherals and you're in business.

Make sure that both devices are free—otherwise, you'll end up with a couple of aborted operations.

We've only tried this with four PETs, but as long as the overall capacitance limit of the cables (available in one, two, four, eight and 16 meters) is observed, you can connect up to 13 PETs.

Full credit for this discovery belongs to Dick McLemore and Earl Hicks of Rockwell International's Autonetics Computing Technology group.

G. E. Eversole
Manhattan Beach, CA

Walter Koetke

COMPUTER BLACKBOARD

Reading, Writing and Computing

"Here cometh the mob. I must go and discover where they are headed for I am their leader." And out the door runs another educator to lead the students "back to basics."

For educators, however, professional responsibility is much greater. The mob shouts "back to basics." The mob is large, powerful and not likely to be stopped, but the mob can be guided. If the public wants to support a "back to basics" movement, then educators must deliver that movement in a manner that will continue to provide students with an appropriate education. If the public wants to reduce expenses, educators must make every effort to reduce expenses without sacrificing the quality of education.

Easy? Of course not! The mob is large, loud and far easier to join than lead. Some valiant attempts to lead have perished, but that underscores the need for leadership. A directionless mob eventually disbands in chaos. A well-directed mob is exceedingly powerful. With guidance from educational leaders, the "back to basics" movement can be directed toward many positive contributions to the education of today's youth.

Does "back to basics" mean a return to rote memorization of arithmetic facts, spelling lists and reading primers at the expense of other subject areas? Does it mean using only traditional teaching techniques supported only by pencil and paper? I suggest that none of these is the real goal of the "back to basics" movement, because our society has evolved well beyond seriously considering a return to the 1940s.

Our students are growing up in a society in which the traditional advantages of the city are available in the country. Quality education, complete medical facilities, a full range of entertainment, fresh food and baked goods, and a broad spectrum of business, financial and legal services are readily available in most small towns. The city has been distributed throughout the country, and this distribution will continue to become more global in the coming years. While this distribution is not without problems, few would seriously propose abandoning all of the inherent advantages.

The computer is an essential key to our distributed society. In almost all areas—medicine, communications, food production, transportation and even leisure—major advances can be traced to the computer. The Information Revolution in which we now live will likely alter life on earth even more dramatically than did the Industrial Revolution. Having extended our physical powers, we are now extending our intellectual capabilities at an unprecedented rate.

As might be expected, since the availability of the computer has altered many of the priorities of contemporary society, it has also altered priorities within the traditional subject matter of our schools. Even the elementary mathematics curriculum is experiencing changes. For example, curriculum planners are beginning to recognize that decimal computation is more important in the elementary school than manipulation of fractions. Note that "more important" does not mean to totally replace or forget the fractions; it merely means that the relative importance of the two topics has been reversed.

As a second example, consider the once practical skill of being able to quickly compute the sum of a long column of numbers. While this activity may be appropriate when developing the basic skills of addition, such an ability is no longer a marketable skill.

Finally, consider the student who has completed one year of algebra. Until recently, he was able to solve only linear equations and some special cases of quadratic equations. Today a student completing first-year algebra should be able to solve virtually any single-variable equation. You don't need a psychological report to appreciate the computer's impact on mathematical self-confidence. With computer availability, students move from knowing how to solve a limited number of equations to knowing they can deal with almost any equation they might encounter.

An official position statement of the National Council of Teachers of Mathematics states that "the astounding computational power of the computer has altered priorities in the mathematics curriculum with respect to both content and instructional practices." A curriculum report of the National Association of Secondary School Principals states that students' ability to add "must be considered within the set of all mathematical skills which every citizen ought to command."

The National Council of Supervisors of Mathematics (NCSM) established a list of ten basic mathematical skills, including the expected "use of the four basic operations with whole numbers and decimals and. . . computations with simple fractions and percents." However, the NCSM list of important skills also includes problem solving, an awareness of the reasonableness of results, estimation and approximation, the mathematics of prediction and computer literacy.

The public has expressed a desire for a "back to basics" curriculum. The responsibility of educators is to provide students with the basic skills that will be necessary to live in our increasingly complex technological society. Educators must respond to public demands, but not by returning to the basic skills of yesterday. They must provide the basic skills of today using the most effective instructional tools of today.

One of today's tools especially appropriate for education's "back to basics" movement is the microcomputer. The few-year-old promise made by myself and others—that computers would rival books in importance to the process of education—took another step closer to reality with the availability of today's microcomputer. Schools can now purchase an amazingly capable microcomputer for $600 to $2500. If you're considering a more expensive alternative, be careful. Notably more expensive microcomputer hardware will probably not give you a better dollar value in an instructional environment.

There are many facets to computer-supported instruction, and the microcomputer represents the majority of those facets actually available today. Microcomputers should and, I hope, soon will be available to students in all grades and virtually all subject areas. Today's "back to basics" movement provides the educator with almost tailor-made justification for microcomputer acquisition.

However, you can temporarily ignore all of the marvelous promise of the computer. When the mob is chanting "back to basics," presentations of computer-supported educational utopias may well anger the mob to violence. These utopias—for example, Papert's Mathland, where ongoing work with LOGO and small children is impressive and may represent the future of education—will not be immediately palatable to the "back to basics" crusaders. Don't fight the mob; help guide them.

If there's one application well-suited to today's microcomputer, it's drill and practice. Students can use the microcomputer to help them learn the basic arithmetic facts, develop spelling skills, write coherent sentences and read at a reasonable rate. These are basic skills on which almost all will agree, and you can enthusiastically propose a microcomputer as an excellent means of supporting the development of these skills, for indeed, that is the case.

Although microcomputer-based drill and practice is a perfect example of using a powerful new technology to teach the same old thing in the same old way, you must deal with the reality that educational changes evolve slowly. If drill and practice firmly plants the foot of a microcomputer in the educational door, then an important change has been initiated.

Note that microcomputer-based drill and practice implies much more than a series of flash card examples for which answers must be supplied. Students should receive immediate feedback regarding each response. If a response is not correct, some indication regarding the nature of the error should be provided. The computer can do this problem after problem—well beyond the endurance of the dedicated teacher and patient parent.

The microcomputer can also advance stu-

dents from one skill level to another after a teacher-specified proficiency level is obtained. Summary reports regarding individual and/or class performance can assist teachers in providing instruction that meets the demonstrated needs of the students.

Drill and practice barely scratches the surface of a microcomputer's ability, but that doesn't matter. Educators should obtain computing facilities because they can certainly provide what the public now demands. After satisfying that demand, they can use the same facilities for the many other loftier instructional goals.

Some may doubt the microcomputers' ability to support loftier goals. Clearly, microcomputers must not be offered as an educational panacea that will be embraced by all. There is not, and never will be, such a simple answer for the many demands placed upon those responsible for the education of today's children. However, even pessimism and a healthy skepticism should not prevent the support of microcomputers in your local schools.

Suppose a school now spends $1000 on a microcomputer that does nothing more than provide drill and practice in spelling and arithmetic to a single third-grade classroom. At the end of the year, all students almost certainly will have mastered these basic skills. And so will the next year's third grade, and succeeding years' third grades, with virtually no additional cost. That's a lot of basic skills for $1000.

Prior to the microcomputer, drill and practice was only rarely, if ever, cost-effective—even when done in an educationally sound manner. That is no longer the case. If your school system doesn't yet have any microcomputer facilities, immediately contact the superintendent or business manager. Offer to count pencils, spot-check the student lavatories or personally verify all figures in the annual budget. Do whatever is necessary to obtain a purchase order for at least one microcomputer. If appropriate, you might also offer to work with teachers and/or write some programs for student use. In so doing, you can make an important educational tool even more effective.

As you lead the mob to the microcomputer and the basic skills it can support, you will find that you can get a good piece of hardware by writing a purchase order, but what about software? Where are the programs that will support the students? Unfortunately, the lack of quality software in proportion to the amount of capable hardware is a reality plaguing the entire computer industry. The vast majority of microcomputer software now being sold is of little or no instructional value. Where does the educator with no computer-related experience turn for software support?

This magazine is one of several helpful monthly and bimonthly publications containing program listings and reviews of both software and more familiar educational tools—books. Be aware, though, that the major value of the program listings is the programming techniques you can learn by studying them. If you already have a working knowledge of the software marketplace or have programming skills, volunteer to assist in your schools.

Most educators are in an unprecedented situation: The microcomputer is the most important educational tool available today. Computer literacy should be an essential subject in elementary and secondary curriculums, yet the microcomputer did not even exist when the teachers were in school. Most will be happy to accept the help of a qualified volunteer.

If you like to read and learn on your own, spend some time at a computer store examining the many introductory books available. If you're unsure which text will be most helpful, choose one by either Tom Dwyer or Bob Albrecht. Both are excellent authors who've been dealing with computers and kids for many years.

High-school students are another source of support. Microcomputers are already widely used, and few high schools do not have at least a small group of capable, knowledgeable student programmers. By providing them with a specific need toward which their efforts may be channeled, all will benefit. Teachers can obtain precisely the programs they want tailored expressly for their classes. At the same time, the student programmers obtain the personal satisfaction of seeing their work used and appreciated by others.

The need for sound educational software is great, and subsequent articles will frequently address this issue. Do not, however, let the immature state of software development prevent your school from beginning to use this innovative technology.

The microcomputer is certain to have a profound effect on public education. Now is the time to begin to explore the astonishing potential of this new instructional tool. Now is the time to use this tool of today to satisfy the public's cry for "back to basics." And while providing the traditional basics many seek, you will also be giving students the basic skills required in today's society.

Walter Koetke, well-known in the computer-education field, is a teacher, author and lecturer and currently serves as computer service director for the Putnam/Northern Westchester (New York) BOCES. Readers are invited to address correspondence concerning this column, which will appear regularly in Microcomputing, *to: Walter Koetke, Putnam/Northern Westchester BOCES, Yorktown Heights, NY 10598.*

BOOK REVIEWS

Basic Microprocessors and the 6800

Ron Bishop
Hayden Book Company, Inc.
Rochelle Park, NJ
262 pp.

When you finish this book, you may or may not understand all microprocessors. But you will certainly know how to use the 6800.

Bishop deals extensively with the addressing modes, the microprocessor's strongest point. He also gives the entire 6800 instruction set and examples of each command, thus doing for the 6800 what *8080/8085 Assembly Language Programming* did for the 8080 family.

For hardware buffs, two chapters detail the many complete systems that Motorola has provided with its array of neatly-fitting LSI chips.

Finally, Bishop includes 15 assembly-language programs, along with flowcharts and descriptions. This section is most useful to the novice programmer who likes to tackle a problem and then see how a competent professional would handle it.

Unfortunately, this book tries to be all things to all people. Thus, the first six chapters are weak.

Chapter one is so basic that it covers the color code resistors. Anyone who needs this chapter won't even understand the rest of the book.

The next three chapters are for the electronics buff with no knowledge of digital electronics, and covers digital logic, binary numbers with octal and hexadecimal notations and binary arithmetic. They might refresh the memories of those who are rusty, but I wouldn't want to learn digital electronics from them.

Finally, chapter six is for the person with no programming experience, and is too scant.

Bishop's chapter endings are also weak. They include summaries that summarize little and quizzes that don't give the answers. These may not be problems to the student in the class-

The Businessman's Business System

MSI Business Computer Systems offer flexibility and expandability unmatched by any other microcomputer system, large or small. Our SDOS operating system is totally device independent and supports up to four users. This means that you can start with a single user, dual drive, floppy disk system today, and add up to 80 megabytes of hard disk with additional workstations tomorrow. As your business grows, your MSI system grows with you—and your software won't become obsolete.

Perform text processing tasks at one workstation while entering sales orders on another. Add a third workstation in inventory control and a fourth in accounting. That's expandability!!!

- MSI Inventory Software, with complete Bills of Material, provides a complete inventory control and management system for manufacturers.
- Complete manufacturing forecasting, with production pick lists, allows automatic adjustment of component inventory levels.
- All transactions resulting in any change to the inventory data base are written to audit trail files listing date, time, operator's name, inventory item, and the changes which were made.
- Sales Order Entry/Accounts Receivable Software displays customer balances and credit standing as new orders are entered. Correct product prices and descriptions are obtained from inventory files if desired.
- Invoices are generated automatically as orders are shipped. Customer statements, with aged accounts receivable, are printed on demand.
- Purchase Order Entry/Accounts Payable Software optionally link to inventory program, in order to easily visualize inventory items which are on order.
- General Ledger programs link to the accounts receivable and accounts payable modules for easy updates and posting.
- If your business is expanding and you would like to know how an MSI Computer System can help you make it more profitable, call or write Midwest Scientific Instruments, 220 W. Cedar, Olathe, Kansas 66061, (913) 764-3273, TWX 910 749 6403 (MSI OLAT), TELEX 42525 (MSI A OLAT).

✓ 144 **Small Computers For Big Jobs**

MSI Midwest Scientific Instruments

room, but are hurdles to the student studying at home. Immediate feedback should be an essential feature of a self-teaching book.

Despite its failings, I recommend this book as a self-instruction tool or for the classroom. You won't learn electronics, digital logic or programming. But you will learn a great deal about the 6800, a mournfully underrated microprocessor.

Bruce Robert Evans, M.D.
Pickering, Ontario

Atari BASIC

Bob Albrecht, LeRoy Finkel, Jerald Brown
John Wiley and Sons, New York
$5.95

By the time this is published, the Atari 400 and 800 personal computers should be established as two of the best-selling computers in the low-price range. Those of us who have been around for a while and have gone through the painful process of learning first Altair BASIC, then Imsai, then Microsoft and finally Level II are going to be a bit miffed at learning yet another.

Wouldn't it be nice if someone would write a complete introduction to every new BASIC that comes along?

Well, if you're interested in the Atari, you'll be happy to know that you can find out everything you need to know about the BASIC from this book. As I understand it, Atari has chosen to give this book to each new Atari owner in lieu of providing their own manual. At last, a micro manufacturer is using existing talent correctly.

Those who are familiar with an earlier book by Albrecht et al will recognize chunks of *Atari BASIC* right away. The book takes the familiar self-instructional format of the Microsoft BASIC book and uses examples similar to those used in *BASIC for Home Computers* (*Kilobaud*, December 1978, p. 14). It is written at a high-school level of comprehension, is occasionally witty, uses examples well and is excellent for someone who knows nothing about computers or BASIC but wants to learn.

I have two problems with the new book. First, the examples are at the same superficial level that has permeated so many BASIC introductions. Second, the unique features of the Atari—the color graphics and sound—are not integrated into the entire book, but relegated to "me too" status in 20 pages at the back.

I have a growing concern about the superficiality. Atari and Sears have linked up to sell some 100,000 computers in the first year, TI has introduced a home computer, and thousands of TRS-80s are in place. Yet, the industry has yet to face the real question consumers come into computer stores with: What can I do with it?

It is one thing to suggest a telephone directory program as do the authors, but actually implementing such a beast is another story.

I, for one, will be happy only when we either stop trying to teach consumers BASIC or teach BASIC as a means to an end rather than an end in itself. Albrecht and company, more often than not, seem to think they have offered the last word on most subjects treated by the book.

As for the color graphics and sound section of *Atari BASIC*, my disappointment cannot be too strongly registered. Why buy a computer with all the bells and whistles if the bells and whistles can't be easily implemented by the user?

This is not to say that Atari graphics are difficult to use; they are actually rather simple. But Albrecht has compressed the graphics section into a minor portion of the book. Most Atari owners aren't going to get to this section until they've read 280 other pages, and then they aren't going to learn any details about what's there. Sound is covered in ten pages, if you count the pages in which sound and color graphics are merged together.

I hope that more complete documentation appears with the Atari 400 and 800 computers. If it does not, we're about to have another lack-of-documentation fiasco on our hands.

I don't want to end on a negative note. Overall the book is excellent. Most computer neophytes are not only going to enjoy this book, but are actually going to learn about BASIC. As if this isn't enough, the book even sports an index! When was the last time you saw that in computer documentation?

If you're interested in the Atari computers, are considering buying a 400 or 800, or are interested in converting your programs from Apple or another BASIC to Atari, this book will more than answer most of your questions.

If someone would only manage to write something as good for assembly language, Pascal and COBOL!

Thom Hogan
Bloomington, IN

PET/CBM Personal Computer Guide

Carroll S. Donahue and Janice K. Enger
Osborne/McGraw-Hill, Berkeley, CA
Softbound, 429 pp., $15

PET/CBM Personal Computer Guide is for Commodore PET owners who have bemoaned the lack of a comprehensive manual explaining how to use their new machines. This compact text will tell you everything you probably always wanted to know about your PET but couldn't get from Commodore's meager manuals. The book is so well-written that it has been authorized by Commodore and carries a Commodore part number as well as the usual publisher's stock number and Library of Congress identifier.

The six chapters and eight appendices carry many details about the proper use of PET BASIC and the physical workings of the machine. Chapter 1 deals with descriptions of the PET and PET BASIC, the differences between RAM and ROM and the different PETs and their different ROM sets. The book does not include the new 80-column units.

Chapter 2 tells how to unpack and set up the PET and the proper ways to use the keyboard and cassette. The authors teach the new user the mechanics of operation and follow with the meat of programming in chapter three: a discussion of instructions for the computer in the calculator or immediate mode, elements, functions, file names and more details on writing BASIC programs. The authors group similar instructions together by function without getting bogged down in the particulars of each instruction. Sample programs are given to illustrate the use of some of the BASIC commands.

Chapter 4 covers each BASIC command, statement and arithmetic, string, format, system and user-defined functions. Each keyword, with its syntax and practical examples of usage, is covered in detail. Common pitfalls are shown. Operational features are shown in the fifth chapter, which discusses keyboard usage, string handling, programmed cursor movement, math functions, graphics and animation. A complete section on files and file-handling techniques is also included.

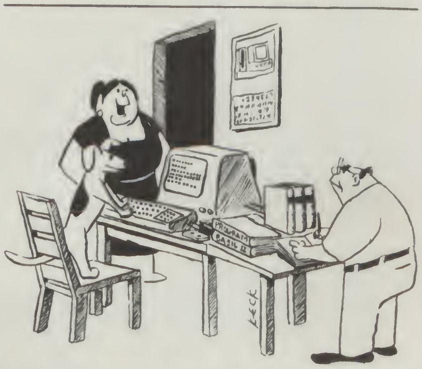
The final chapter consists of system information on the computer itself. Technical information is presented on the PET system organization, a memory map, how the BASIC interpreter works and how BASIC formats information for storage.

The eight appendices cover character codes, error messages, solved program examples, a bibliography of BASIC and number conversion tables. Also included is a useful appendix covering the changes that need to be made in the text in order to make it compatible with the old ROMs. The authors are to be commended for pointing out the differences between ROM sets and the effects on programming. The last appendix is a summary of PET features. Interspersed in the text are 17 tables summarizing such topics as keywords, string symbols, memory map blocks and character codes.

As complete as the book is, it does not cover any of the Commodore peripherals such as disk drives or printers; evidently, the authors preferred to emphasize operation of the main machine.

Every new owner, no matter how well versed in any dialect of BASIC, should read this excellent instructional manual in the ways of using the PET. If you have had your PET for a while and are pretty familiar with it, you will still find much good information in this book. It makes a great reference text. The clear, simple writing style makes programming concepts easy to understand. Whether you're a PET owner or a prospective owner, this book is for you.

Jeff Knapp
Charleston, WV



Never mind your books, Harold. Spot just solved the programming problem for you.

Edited by Dennis Brisson

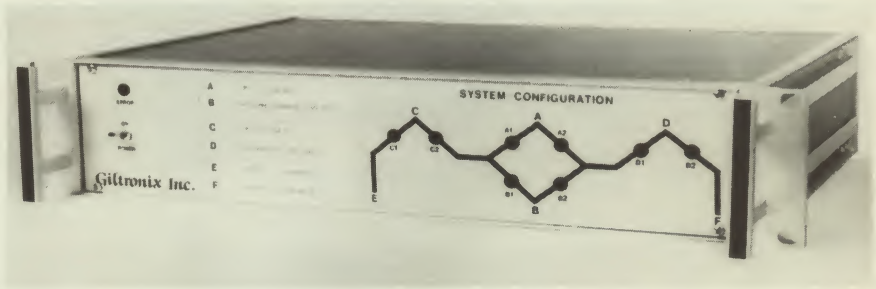
NEW PRODUCTS

Software-Selectable Video For the PET

The MTU K-1008-6 PET Graphic Interface is a high-resolution graphic display board for new or old Commodore PET computers that provides video mixing and ROM sockets. It features five ROM sockets that can be set at the same or different addresses with software control of whichever sockets are enabled. The system is automatically restored to the user-selected configuration after power-up or reset.

The MTU K-1008-6 provides user control over a matrix of 64,000 dots (320 wide × 200 high). Serving as an 8K byte expansion memory when not used for graphics, the board also creates a KIM/MTU expansion bus supported by various MTU products. On-board expansion allows use with optional light pen. Price is \$320. K-1007-2 connector board for the old PET is \$35; K-1007-3 connector board for the new PET is \$59.

Micro Technology Unlimited, PO Box 12106, Raleigh, NC 27605. Reader Service number 487.



Giltronix' interface controller.

6 MHz Central Processor Card

The CP 600 is a 6 MHz Z-80 eight-bit central processor card that can increase computer bus system speed by 50 percent. It conforms to the IEEE 696 standard. Two on-board ports extend memory addressing to 24 bits and I/O addressing to 16 bits. This allows 16 megabytes of system memory and 65K of system I/O.

RAM refresh occurs as a standard S-100 memory read cycle, minimizing the need for special logic on RAM cards. All eight lower address bits are used for refreshing to accommodate 64K dynamic RAM devices. A refresh localizer allows intensified parity checking in the area of currently executing programs. All bus cycles, including the refresh cycle, are three "T" states long. The CP 600 features a stable crystal-controlled master clock and jumper-selectable on-board-generated memory and I/O wait states, as well as an on-board EPROM wait.

International Product Development, 1708 Stierlin Rd., Mountain View, CA 94043. Reader Service number 489.

RS-232 Automatic Interface Unit

The GA6S8 is an automatic interface controller that can interconnect up to six devices (CPUs, terminals, plotters, printers, modems) in various configurations. This software-controlled unit complies with the RS-232 and IEEE-488 specifications and is controlled by the 8085 microprocessor. Changing from one configuration to another requires a single command from the computer.

The GA6S8 is capable of switching eight pins of the 25-pin EIA connector. It allows up to five master ports, leaving one port slave. The unit operates at baud rates from 110 to 9600.

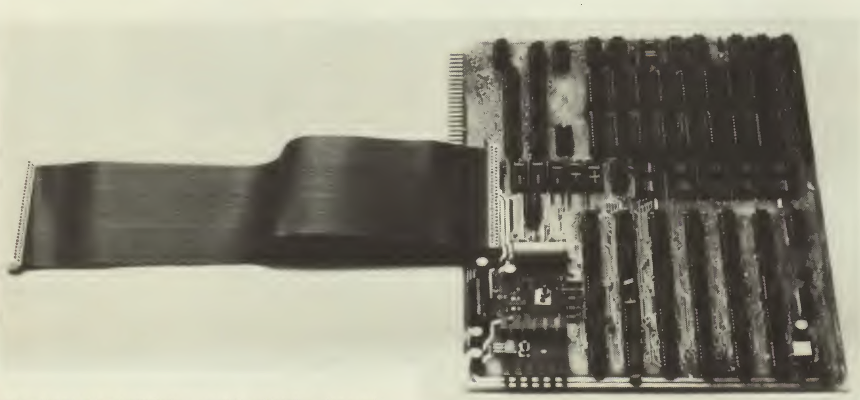
Giltronix, Inc., 450 San Antonio Ave., S44, Palo Alto, CA 94306. Reader Service number 496.

Small-Business Computer

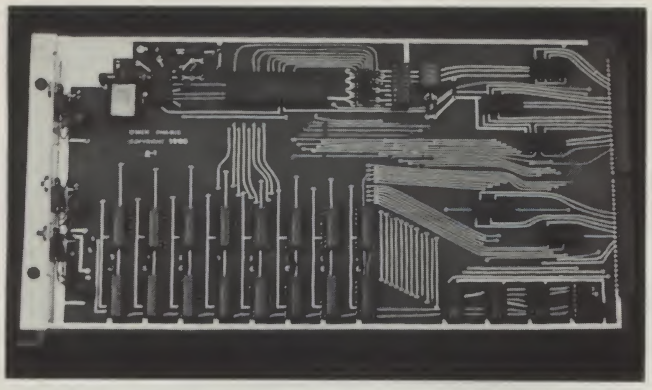
The Astrocom 760 computer consists of a microprocessor-based keyboard/display terminal with 65,000 bytes of integrated circuit memory, a single or dual flexible disk drive subsystem that stores up to 1,000,000 additional bytes of information and an optional matrix printer. Twelve application packages—general ledger, order entry, invoicing system with inventory control, open item accounts receivable, cash receipts, accounts payable, cash disbursements posting, purchasing and receiving, inventory control, fixed asset accounting, payroll and mailing list management—are available.

Astrocom Corporation, 120 W. Plato Boulevard, St. Paul, MN 55107. Reader Service number 491.

The Astrocom 760 computer system.



The MTU K-1008-6 graphic display board.



The H8 color graphics board.

The MQI 150 matrix printer.

Color Graphics for the H8

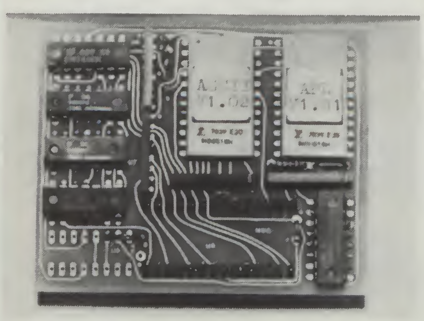
A color graphics board for the Heathkit H8 computer that generates high-resolution color graphics has recently been introduced by Owen Phairis Computer Products, PO Box 3400, Big Bear Lake, CA 92315. The board is fully compatible and may be put in any one of the available slots within the H8 mainframe. It generates eight different graphic display modes and up to eight different colors. Highest resolution is 256 pixels by 192 pixels. The board also contains 8K of static read/write memory, which is address-selectable by DIP switch. On-board rf modulation is also included. Price is $379, kit; $479, assembled. Reader Service number 493.

Lowercase for Centronics Printers

The PBB-100 Piggyback Board adds lowercase ASCII print capability and alternate character set selection under software control to most Centronics printers. All 100, 300, 500 and 700 series printers, including the 101/101A and the 779 printers, that use the standard TMS4103-type character generator ROM are candidates for conversion. The PBB-100 is designed to replace the ROM character generator integrated circuit in the printer electronics. Customer installation involves unplugging the character generator ROM from its socket, adding two new jumper wires to the printer electronics board and plugging the piggyback board into the ROM socket. The printer may be restored to normal by removing the piggyback board and replacing the ROM chip at any time.

The PBB-100 provides the printer with the capability to print the full 96-character ASCII set. It can also be equipped with an optional second character set. Price is $95.

Digital Systems Engineering, 12503 Kings Lake Drive, Reston, VA 22091. DSE will install the PBB-100 for an additional $25 charge. Reader Service number 495.



The PBB-100 Piggyback Board.

19-Key Hexadecimal Encoder

The JE600 is a 19-key hexadecimal encoder kit that provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for eight-bit microprocessor or eight-bit memory circuits. Three additional keys are provided for user-defined operations, with one having a bistable output available. The outputs are latched and monitored with nine LED readouts. Also included is a debounce circuit for all 19 keys and a key entry strobe. Interfacing with other equipment is accomplished by a 16-pin IC connector. Only +5 V dc is required for operation. Price is $59.95 (kit); the enclosure is $44.95.

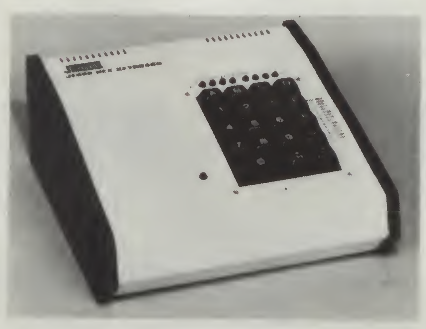
Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002. Reader Service number 490.

The MQI Matrix Printer

The MQI 150 matrix printer has a speed of 150 cps, with bidirectional logic seeking. It has a minimum head life of 200 million characters. You can select 80, 132 or 136 columns, six or eight lines per inch. The matrix is 9×9, upper and lowercase with descenders. The printer will accommodate multi-part forms up to original-plus-five copies, from two to 15 inches wide. Other paper-handling features include top of form printing, tractor feed and skipping around perforations.

Designed for small-business computers and advanced hobby markets, the MQI 150 is 23×8×14 inches, weighs 28 pounds and will operate on a variety of standard power sources—110, 120, 220 or 240 volts, ± 10 percent, 50 or 60 Hz. Price is $1295.

MQI Computer Products, 18381 Bandilier Circle, Fountain Valley, CA 92708. Reader Service number 494.



Jameco's 19-key hex keyboard.

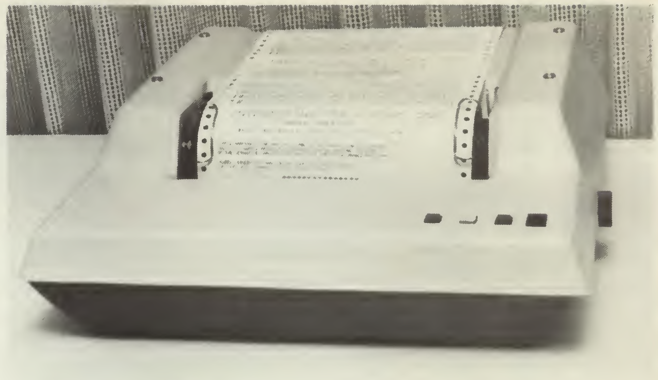
OSI Modification Kit

Now you can overcome the 24 character/12 line video display and the 300 baud cassette limitations of the C1P and Superboard II with the Super-Mod Kit from A. H. Systems, Inc., 9710 Cozycraft Ave., Chatsworth, CA 91311. It provides a 48 character/26 line video display and software selection of 300 or 1200 baud for cassette and RS-232 operation. It also provides an RS-232 port, start/stop control of the cassette and doubling of system clock speed (from 1 MHz to 2 MHz). Parts and documentation to perform the modification, which should take about 12 hours, are included with the kit, which costs $95, plus $3 for postage and handling. Factory installation of the kit costs $100, plus $20 for postage, handling and insurance. Reader Service number 492.

Digital Capacitance Meter

The Micro-C Probe is a microprocessor (6502)-based digital capacitance meter offering a range from .1 pF and an accuracy rating of .1 percent. Full auto-ranging and auto-zero to automatically eliminate the effect of lead or stray capacitance from the reading are standard with

III's Micro-C Probe.



Coosol's 80-column dot-matrix impact printer.

the unit, which is targeted for the hobbyist and service markets, as well as for the laboratory and quality-control departments of electronic R&D and manufacturing firms.

Multiple limits comparators allow sorting, tolerance testing or inspection of up to 16 sets of limits at once. The statistic function provides the standard statistics from a measurement session and also allows random sampling of incoming capacitors to determine the probability that the entire batch is within specifications. Price is $299.95.

International Instrumentation, Inc., Box 3751, Thousand Oaks, CA 91359. Reader Service number 474.

TRS-80 High-Speed Cassette System

The TC-8 is a high-speed cassette system for the TRS-80 Level II computer that allows TRS-80 users to load programs five times faster than with the present TRS-80 cassette recorder and attain better reliability. Based on the TC-3, the TC-8 and its software support the saving, loading and verifying of BASIC programs, system programs and data files. This system includes eight-character named files, the ability to list the directory of all files on a tape, verification of saved files and a more efficient data file storage technique that closely resembles a disk system. Prices are $90 (kit) and $120 (assembled).

JPC Products Company, 12021 Paisano Court, Albuquerque, NM 87112. Reader Service number 485.

Printer/Electronic Typewriter

The Typrinter 221 is an intelligent daisy wheel printer with five built-in microprocessors, providing complete text formatting, including proportional spacing, right justification and bold characters. It can also function as an advanced electronic typewriter with an alphanumeric display showing the current line, column position and lines remaining to the end of the page.

The Typrinter 221 is compatible with all micro, mini and mainframe computers and utilizes a parallel Centronics interface, with RS-232C and IEEE-488 interfaces also available. It can respond to formatting commands embedded in the text, eliminating the need for additional text-formatting software.

You can select from three different sizes of type (elite, pica or mikron). Each standard daisy wheel has all the characters necessary to print in Spanish, Italian, French and German. The Typrinter can also print in reverse; that is, white characters on a black background. Price is $2750.

Howard Industries, Inc., 2031 E. Cerritos Ave., Bldg. 7K, Anaheim, CA 92806. Reader Service number 486.

40/80-Column Printers

Coosol, Inc., PO Box 743, Anaheim, CA 92805, announces a 40-column friction feed and an 80-column tractor feed dot-matrix impact printer. These printers are microprocessor-controlled and programmable with 32 system-level software commands. Features include graphics dot plotting mode, 96 ASCII characters with upper and lowercase, nine software-selectable sizes from 5×7 to 10×14 character fonts, reverse font printing capability, standard parallel and serial interface, selectable baud rates from 110 to 9600 baud and adjustable tractor width for paper size selection. Kit prices are $295 for the 40-column printer and $455 for the 80-column printer; assembled printers cost $325 and $485 for the 40-column and 80-column printers, respectively. Reader Service number 497.

The TC-8 Cassette System for the TRS-80.

Howard Industries' Typrinter 221 Computer Printer.

Edited by Dennis Brisson

NEW SOFTWARE

ISAM for CBM

Creative Software, PO Box 4030, Mountain View, CA 94040, has introduced an Indexed Sequential Access Method (ISAM) file-handling routine for the Commodore Business Machine 2040 Disk Drive. Using 2K bytes of assembly-language subroutines, the software supports the following functions: CREATE a new ISAM file, OPEN an old ISAM file, READ key and data from a file, WRITE key and data to a file, READ NEXT key and data from a file, DELETE a specific key and data from a file and CLOSE the ISAM file. The software supports up to five open ISAM files at one time and will run on any 16K or 32K CBM 2001 computer. The diskette version is $99.95, plus $2.50, shipping.

Creative Software, PO Box 4030, Mountain View, CA 94040. Reader Service number 477.

Commodore Mailing List Program

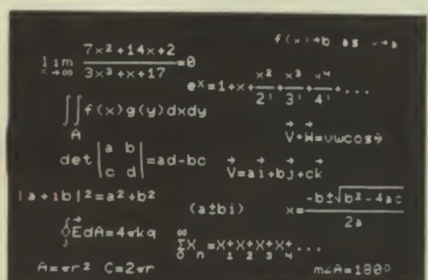
MAIL LIST is a mailing program for the Commodore CBM 16K and 32K computers with CBM 2040 disk drives and CBM or ASCII printers. It stores a large number (1050) of records on a single disk and allows the user to adjust the length of all fields. Mailing labels can be printed out according to alphabetical or zip-code order. Also, records can be identified and selected as active or inactive according to a user designated utility field; for example, CBM users. Price is $95.

CDS Corporation, 695 East Tenth North, Logan, UT 84321. Reader Service number 499.

PET Character Sets

Your PET computer can display mathematical formulas and expressions for scientific, technical and educational use with the addition of a new ROM character set from West River Electronics R&D, PO Box 605, Stony Brook, NY 11790. In the graphics mode the PET operates normally, but in the lowercase mode all the graphics characters have been replaced by mathematical symbols such as superscripts, subscripts, square roots, integrals, derivatives and sums.

A foreign language ROM that contains the extra characters needed for German, French, Spanish and Slavic languages is also available. Each ROM set—for use with the new model PETs—costs $75. Reader Service number 488.



Mathematical symbols for the PET.

Network Operating System

CP/NET supports network technology by allowing independent microcomputers access to common (and often expensive) facilities, such as peripherals, programs and data bases, via a network. Designed for 8080, Z-80 and 8085 microprocessors for end-user adaptation to a wide variety of network hardware, it operates with CP/M and MP/M to support CP/M-compatible products. Applications range from multi-terminal word processing/data base systems that share disks and printers to industrial process control systems that use single board computers, without disk or console facilities, as slaves. CP/NET consists of one or more masters running MP/M and one or more slaves running CP/M or MP/M.

CP/NET is network independent. For example, through simple modifications, a network may be constructed with any combination of shared memory, serial links or parallel I/O with any protocol, such as X.25, BISYNC or SDLC.

Digital Research, Inc., PO Box 579, Pacific Grove, CA 93950. Reader Service number 482.

Star-Gazing Program

COMP-U-SKY is a high-resolution graphics program that responds interactively with the user via text and joystick (or game paddles) to locate, identify and provide information on stellar objects. Designed for Apple Computers with 48K memories, Applesoft firmware card and at least one disk drive, it presents graphic displays for eight directions, as well as overhead, for any location on the earth. This program adjusts for latitude and longitude, viewing time and date, including the Earth's precession (or wobble). The right ascension and declination are provided for all objects in the tables.

Constellations, planets, the sun, moon and stars are presented in graphic displays with several command modes available. C command connects constellation lines; L command locates the object of your choice from star tables that contain stellar objects. The program then tells you what time the object rises and sets, the direction to look in and the object's brightness.

For star-gazers wishing to perform equatorial, ecliptic, horizontal and precession conversions, an easy-to-use Calculation Utility is included. In addition, solar system astronomical data can be presented in this utility. Price of the diskette version is $39.95. An advanced version with multiple star tables costs $79.95.

Scharf Software, PO Box 18445, Irvine, CA 92713. Reader Service number 483.

Apple DOS

DOS 3.3 is an improved disk operating system for the Apple Disk II floppy disk subsystem.

In addition to the features of the earlier DOS versions, it uses a 16-sector storage format that increases the capacity of a diskette by more than 20 percent—from 116 to 143 KB. It can copy a program from one diskette to another using a single disk drive. This gives even the single disk drive user the ability to create backup copies of programs and files. It includes a program that converts existing software libraries and data files in 13-sector format to run under DOS 3.3. It also includes a utility diskette to temporarily convert back to 13-sector format. The $60 price includes PROM replacements for the disk drive controller card, an IC puller, a master demonstration diskette, a diskette that supports the use of software stored in 13-sector formats and the DOS 3.3 manual.

Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014. Reader Service number 480.

TRS-80 CP/M2

Lifeboat Associates, 1651 Third Avenue, New York, NY 10028, has released CP/M2 for the TRS-80 Model II with 12 million bytes of mass storage. The new system features extended density format for each of up to four floppy disk drives. A total of nearly two and a half million bytes of storage is possible with floppy disk drives alone.

The new CP/M2 includes a powerful menu-driven configuration program that allows total control of the parallel printer port and both serial ports of the TRS-80. The printer port software can be set to completely control a dumb printer that does not have page control, or the

software page control can be disabled for printing checks or mailing labels.

The menu selections of the configurator include functions to set baud rates from 134.5 to 9600 bits per second for the serial ports. You can also specify X-ON/X-OFF, ETX/ACK or hardware handshaking protocols. An ADM-3A emulation program that allows the TRS-80 to be used as a terminal through the serial ports is included. The system is offered with Corvus hard-disk capability for $250 and floppy only for $170. Reader Service number 498.

Accounting/Statistics Package for Nursing Homes

Beechwood Software, developed by nursing home owners/operators, can be used specifically for nursing homes and similar long-term care facilities. It includes systems for patient statistics, accounts receivable, accounts payable, inventory, payroll, general ledger, checking account and patient spending accounts. The general ledger system can accommodate even the most complicated chart of accounts. The software operates on various microcomputers (such as the Cromemco System 3 and the TRS-80, Model II) and configurations of peripheral equipment using a CP/M or CP/M-compatible operating system with at least 64K of RAM and one megabyte of storage capacity.

Brook Chambery, Beechwood Software Division, 900 Culver Road, Rochester, NY 14609. Reader Service number 481.

Bluebird Software

Bluebird's Computer Software, 2267 23rd Street, Wyandotte, MI 48192, has recently released the following new software for the TRS-80:

Reformat—programming aid used prior to compiling with the Microsoft BASIC Compiler. This machine-language program will reformat any TRS-80 BASIC language source file into a format completely acceptable to the Compiler. Price is $24.95.

BIO—biorhythm program that outputs not only the standard bio-curves, but also prints a complete analysis on a day-to-day basis of the interactions of the physical-emotional-intellectual cycle. Price for the cassette or disk version is $29.95.

Max/Min-It—linear programming software package with documentation that illustrates how to set up your programming problem with hints on what to look for in defining variables, constraints and functions. Price is $29.95. Reader Service number 484.

M6809 Relocating Assembler

Cincitek Software, Box 19365, Cincinnati, OH 45219, offers a resident M6809 Relocating Assembler and Linking Loader on five-inch Flex disks configured for SWTP systems. The assembler supports relocatable and absolute code. Common blocks analogous to those in FORTRAN are also supported. Other features supported are eight character labels, global and local labels and handling of M6800 and M6801 instructions.

Four other programs available are the One Pass Link Editor, Two Pass Link Editor, Global Cross-reference Generator and Object Displayer. All six programs and a users manual are available for $200. Reader Service number 479.

North Star Utility

North Star BASIC Utility Set (N*BUS) features a coresident source program editor with editing facilities that significantly reduce programming time and error. Editor encompasses 26 separate commands, including global locate and change, line insert and append, copy, move, erase columns, delete, print and line scrolling. N*BUS is delivered with a BASIC program that personalizes the machine code of Editor to any release 4 (or later) version of North Star BASIC, regardless of origin, arithmetic precision, hardware/software floating point or DOS density.

N*BUS also features BPAK, a program pack utility; BPRT, a program-formatted list and cross-reference utility; and RE, a file rename utility. Price is $69.

SZ Software Systems, 1269 Rubio Vista Rd., Altadena, CA 91101. Reader Service number 476.

Master Accountant Business Software

Master Accountant is a business system for CP/M-compatible microcomputer systems, from Computer Services, PO Box 2292, Hickory, NC 28601.

The Accounts Receivable package is designed as a complete invoicing and monthly statement generating system that keeps track of current and aged accounts receivable. It maintains a complete file for each customer consisting of the customer's name, address and phone number, along with the customer's type of account, current balance and tax rate. It is designed to interface with the General Ledger system to provide automatic monthly journal entries to the General Ledger, or it may be run independently to be used with your existing accounting system.

Also available are Accounts Payable, Payroll and General Ledger. Each package costs $100. Master Accountant is written in Microsoft Disk BASIC and is available on eight-inch soft sector diskettes. Reader Service number 478.

TRS-80 Utility

VARKEEP is a TRS-80 Level II BASIC/Disk BASIC utility that allows you to save, restore and otherwise manipulate one set of data that may be common to two or more programs. This disk-resident machine-language utility works with all TRS-80 computer disk operating systems including Percom's OS-80 and TRSDOS.

VARKEEP adds four BASIC commands—NAME SAVE, NAME RESTORE, NAME DELETE and NAME CLEAR—to protect the values of all variables from erasure by LOAD, RUN, NEW and CLEAR commands; restore to a program all variables used by a previous program; delete variables no longer needed in order to reclaim memory space; and change the amount of string space available to a program while it is running, without losing any variables or any strings. Price on minidiskette is $19.95.

Percom Data Company, 211 N. Kirby, Garland, TX 75042. Reader Service number 475.

LETTERS TO THE EDITOR

The Eyes Have It

It is regrettable that "Physician Automate Thyself" (May 1980, p. 101) listed the word optometrist. While an optometrist is a professional in every sense of the word, the article concerned physicians. No optometrist I know of would call himself that because he isn't. The article was a good article that reflects what is happening in all good professional offices. I use a Vector Graphic MZ computer in my professional practice and am in the process of customizing several programs. There are, however, programs available for the professional optometrist to accomplish, via the computer, a myriad of professional activities.

However, on page 19 of the July issue you really blow it. Either your editor who included this is ignorant of the professional antagonisms that exist between the two professions, or he is propagating the ophthalmological line, or he

simply didn't read what he was including. At any rate, the inclusion is seriously pro-ophthalmologic and seriously anti-optometric.

You people should not be involved in any way in professional squabbles. It is none of your business and has nothing to do with the computing industry.

Dr. J. H. Robinson
Optometrist
Creston, IA

Our sincere apologies to anyone who may have been offended. It was certainly not our wish to become entangled in the ongoing wrangle between ophthalmologists and optometrists. In fact, we were not previously aware of the antagonism between the two groups prior to the publication of the May article and the July comment. In the months since then, our eyes have been opened. Suffice it to say that we are in no way anti-ophthalmologist or anti-optometrist. We respect equally their professionalism and dedication, but have no interest or opinion concerning their feud. Let us hope that those concerned will realize that our inappropriate use of terminology is merely illustrative of the layman's continuing confusion between the two groups.—Editors.

A Rolling Stone Gathers No Moss

David O'Neil, in his June 1980 *Microcomputing* article, "Physics Teacher," states that the velocity of a spherical mass rolled down an inclined plane "would be the same as if it fell straight down." Not so, students! Assuming equal diameters, a solid sphere and a hollow sphere (and, for that matter, a disk and rim) would all reach the bottom at different times and with different velocities—all slower than if they had been dropped straight down. The reason is rotational inertia. A calculable amount (depending on the mass distribution) of the object's original potential energy is connected to rotational energy as opposed to translational velocity. Remember the yo-yo?

Robert Redick
Chevy Chase, MD

Rotational inertia has been considered an unnecessary complication to the basic physics concept. An object rolling down a ramp, regardless of its mass distribution, will go slower than a frictionless air cart or puck. But the velocity is not "lost"; it is stored as rotation. Further on in the same program (Inclined Plane), a value can be entered for friction due to drag-type resistance or rotational inertia.

Rotation would also affect the Pendulum program. In Collisions, I specifically mentioned that rolling inertia is to be ignored, but neglected to do so in the above two programs.

If a solid sphere of radius R is rolling down an incline with no slippage, the conservation of energy states that the potential energy at the top equals the kinetic energy at the bottom, which now includes rotation:

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$,

which reduces to

$gh = .7v^2$ or $v = \sqrt{(gh)/.7}$,

where $I = (2/5)mr^2$ and $\omega r = v$.

You may wish to include the following in Inclined Plane.

```
282 IF S$ = "KG" THEN G = 9.8 : GOTO 286
284 LET G = 32
286 LET V = SQR((G*H)/.7)
288 GOTO 295
```

David O'Neil
Greenacres, FL

Routine Refinement

The subroutine in C. Kevin McCabe's article, "Conjure up a GET Command for Sorcerer," (April 1980) has been in use for some time as part of a system-enhancing program called "DMI/OS." The routine will work well, but will be slowed by using the Sorcerer's receive vector. The call will be three to five times faster if the call is switched to the monitor keyboard routine. This can be accomplished by changing the data sequence in line 60010 to 205,24,224, 50,0,0,201.

Our DMI/OS offers the GET function in the form we suggest plus eight other system enhancements for the Sorcerer in any of its standard BASIC configurations. The software is transparent to normal operation, but can change inputs and outputs or offer advanced cassette operation to the user.

Lyle Blake
Digital Magic
St. Catharines, Ontario
Canada

To an extent, Mr. Blake is correct. My routine will work marginally better using the monitor's keyboard routine, rather than the RECEVE entry point—but only where the keyboard is the selected input device. As written, my routine is useful for any input device at all. In normal operation, RECEVE jumps to the keyboard routine; where another input device has been selected with SET I = [input device], RECEVE jumps to the appropriate monitor input driver.

C. Kevin McCabe
Chicago, IL

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70 + 118 = Good Idea

As I sat at my desk writing a dumb terminal program for my OSI Superboard II, my son barged into my lab with the July issue of *KB Microcomputing* (the only excuse for entering my lab without written permission).

I combined the OSI dumb terminal program and modification on p. 70 with the POKEing of OSI machine-level programs in unused RAM as demonstrated on p. 118 to form Program Listing 1. You can test the program by putting the newly installed switch on tape, placing a blank tape in the machine and putting the cassette machine on record. When you run the program, keyboard entries will echo through the tape recorder to the screen.

```
10 FOR X = 0 TO 50
20 READ Y
30 POKE 546 + X,Y
40 NEXT
50 POKE 11, 34 : POKE 12, 2
60 A= USR(B)
70 DATA 162,2,189,73,2,157,192,1,202,16,247
80 DATA 169,3,141,0,240,169,141,141,0,240
90 DATA 88,32,237,254,72,173,0,240,41,2,240,249,104,141,1,240,208,239
100 DATA 76 76,2,72,173,1,240,32,45,191,104,64
110 END
```

Program Listing 1.

Richard Wright
Tiffin, OH

Thick as a Brick

C. Brian Honess, in his letter in the June 1980 *Microcomputing* criticizing my book review of *57 Practical Programs & Games in BASIC* in the February 1980 *Microcomputing*, seems to have missed a lot. Three of Mr. Honess's points are trivial. He says three pages of BASIC statements are "filler." Maybe they are to him, but to the neophyte, they serve as an introduction to the programming in the book.

My critic also protests that these programs were written and tested on an IBM mainframe rather than on a microcomputer. This is a standard practice in developing commercial software. However, I think that Mr. Honess blames all his problems translating to his version of BASIC on this. He also worries that the standard flowchart symbols are not used. At least he is correct this time, but I refuse to consider this a major flaw.

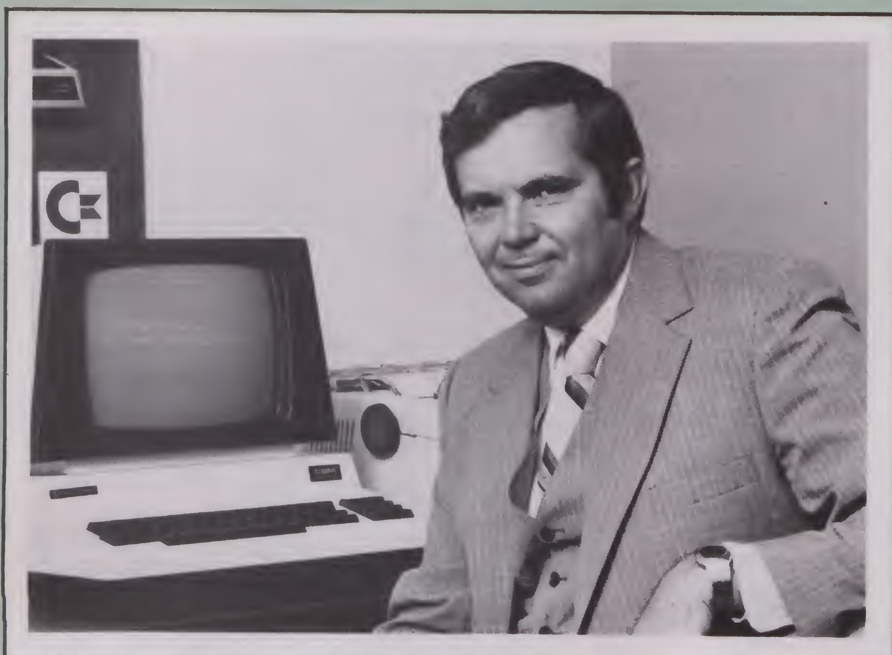
Mr. Honess's main complaints center around the programs. He states that the equations are inaccurate. I wish he had given some examples. He states that these programs could have been written by anybody with "the imagination of a brick." That is entirely the point I made in the review. The merit of this book is that it provides simple programs that are too time-consuming to write for a single application. It's easier to get them ready-made.

As to Mr. Honess's criticism that the English is poor and the book not well-written, I can only deduce that he has not read many other inexpensive books on programming. For \$3.50 (\$4.95 in Canada), you don't get the equivalent of Osborne's books!

Bruce Evans, M.D.
Pickering, Ontario
Canada

Commodore: New Products, New Philosophies

An interview with Bill Robinson, vice-president—systems, Commodore Business Machines.



What about the "secret" low-cost computer that was sneak-previewed at the June CES show in Chicago?

Bill Robinson was previously director of sales for NEC Information Systems. Prior to that he held managerial positions with Basic Four, Hewlett-Packard and United Computing Systems.

Yes, we did show a low-end product, which is part of an entirely new generation of computers that will complement, but not replace, the PET.

This little computer, based on our MOS Technology semiconductor subsidiary's own VIC (video interface chip), was undergoing some engineering tests. We took the opportunity at the CES show to bring together some of our engineers from both coasts and have them meet in Chicago. They met in one of the meeting rooms, which happened to be enclosed with a polarized window, and we decided to let passers-by see what was going on because it was a rare opportunity to see the birth of an entirely new computer in progress.

Can you give us more information on the VIC?

The product is still under development and doesn't even have a name yet. It's a low-cost computer, around $300 or $400, that hooks up to your television set and offers a variety of features. It has a 5K memory with 1K for color. It's entirely new, although it does make use of our 6502 chip. It connects to a television set, offers sound through the television speaker and will have plug-in ROM cards and an expansion motherboard to add memory and accessories. The small computer will have its own full set of peripherals, including tape cassettes, disk drive, printer, modem and more.

Will the VIC eventually replace the PET?

Not at all. The VIC is aimed at those who would like to have a small and inexpensive computer. This computer will be ideal for special purposes such as telecomputing. It

Special thanks to Commodore Marketing Strategist Michael S. Tomczyk for his assistance in arranging this interview.

will also be an excellent computer—in terms of price, power and documentation—with which to learn about computers in general.

Are you implying that this computer will be well-documented?

Not implying—promising. That's one of the commitments we've made. We want this to be a computer that anyone can learn how to use, but that has enough additional documentation to enable an experienced programmer/hobbyist to get inside and let his imagination work.

Will the VIC be compatible with the PET?

Some programs that work on the PET will also work on the VIC, depending on the complexity of the program. PET programs that have disk calls and other peripheral-related subroutines will clearly not work on the VIC, which is intended to be a small, self-contained portable computer. Otherwise, the BASIC running on the VIC will be a subset of that currently running on the PET and larger Commodore systems.

Is this a handheld computer?

Yes, in the sense that it's no larger than a tape recorder and has the power and capability of many of the desktop computers now on the market.

When will a modem be available from Commodore?

Actually, we have modems available now for the PET, and, assuming that the interface for the VIC includes an RS-232 bus, then almost any of the commercially available modems currently on the market will work. Given the relatively low cost of modems, we don't see the availability of modems preventing anyone from using the VIC for telecomputing applications.

When will your one-megabyte disk drive be available?

We are currently in production on the 8050 disk drive, although we're still evaluating field test results. Barring any unforeseen surprises from the field test, we will begin shipping the product by late summer or early fall.

When can we expect to see color on the PET?

Color has already been demonstrated at various conventions here in the United States and at Hanover Fair in Germany, so we're obviously working on a color PET. The new PET will connect to any color television set and will offer many of the features available on the present PET/CBM, plus some new ones.

What other new products do you have planned for the PET?

We are making a strong effort to not discuss products on the drawing board or unavailable to produce and sell. At the same time, we're trying to be as open and candid as possible in discussing our activities as a company. Striking a balance is a difficult challenge.

In terms of new products—and we're talking about the future—we're looking at several types of disk drives. In addition to our 8050 one megabyte drive, which is close to introduction, we're working on a high-capacity eight-inch floppy disk drive, a hard disk unit and a low-cost single/dual disk drive. In addition to the color PET and the VIC, we will have a voice-recognition device and one or more new printers.

We also have an interest in larger systems that are able to address more complex business applications that require more memory than has been traditionally available on the so-called personal computer. This market is likely to be among the highest-growth markets for manufacturers of any size computer.

Our experience has shown that the buyer of the small or personal computer who has gained experience and is business-oriented is now ready to move into a more advanced multi-terminal system capable of supporting larger data bases. This market has been attacked by minicomputer manufacturers for years, and yet the price of the average mini is still up in the \$30,000 to \$40,000 range—in many cases, far in excess of that which is affordable by the average small businessman taking his first serious step in automation.

The introduction and availability of these products will depend on a variety of factors ranging from engineering to manufacturing and distribution.

What about software?

We recently hired a director of applications software who will be addressing this question and will conduct a thorough evaluation of all software available for the CBM/PET, including software we can offer ourselves and what outside software houses can offer in the future.

In order to commit ourselves to the U.S. and world market with today's competitive pressures and user requirements, we are prepared to commit more resources to applications software. Our software group is in the process of evaluating existing software applications packages—from U.S. sources and abroad—which are well-documented, installed in multiple locations and time-tested. This software will be culled, cataloged and offered for sale or licensed by Commodore, by the author or perhaps on some licensing/royalty basis. Our goal is to provide the widest possible selection of high-quality applications packages for the world market. We will be stressing business-applications packages.

An increasing number of software houses are developing or adapting their programs to Commodore systems. A recent example is VISICALC, which is available now for the PET/CBM through Personal Software, Inc.

What changes do you anticipate in hardware and operating systems and will they be compatible with previous models of the PET/CBM?

We certainly anticipate constant improvement in hardware and in systems software as new technology becomes available. By having a vertically integrated company, we can develop our own semiconductor products in sufficient volume to provide an important competitive edge. Our design engineers are constantly looking for new techniques to design and manufacture advanced semiconductor products, which dictate changes in microprocessor products.

Beyond this, since we are our own supplier, we can and do bear in mind the desirability of upward compatibility for existing users. Clearly, the user who has bought a PET or CBM computer would like the ability to preserve his investment in applications software as well as hardware.

Will 4.0 BASIC, being introduced on new PET/CBMs, necessitate rewriting existing programs?

Existing programs in PET BASIC can be loaded and run with little or no modification, depending on the complexity of the program. However, as with any new operating system, the degree of sophistication at the machine-language level will have an impact on conversion of programs.

In other words, programs written in simple BASIC should require little or no modification, while programs with numerous machine-language calls will be affected by the new DOS and will require more extensive modification. All available input to date suggests that conversion to 4.0 BASIC and 2.1 DOS is worthwhile with regard to improved performance and flexibility.

Commodore's marketing organization recently underwent some major changes. Could you explain these changes and how they're affecting the company?

Commodore has initiated several important changes—both domestically and internationally—that will have an impact on our marketing organization. In the U.S., we recently shifted from a two-tiered distribution system to a network of Commodore-owned-and-operated regional distribution centers. These centers provide our dealers

with product warehousing, depot-level maintenance, training and educational services, applications software support and administration.

This system gives us much tighter control and allows us to be more responsive to our dealers, who now work directly with company representatives in each region instead of through intermediary distributors. Our customers are also benefiting from better product availability, service and support.

Six regional centers are now in place; a few are still being staffed. When completed, this system will bring greatly improved support to our expanding U.S. marketplace. This, then, is the most noticeable change in domestic marketing.

A change that will be seen worldwide—most notably in the U.S.—is the strengthening and reorganization of our market support capabilities. Major efforts are being advanced by Commodore in the areas of evaluation, endorsement and development of superior applications software packages sought after by dealers and customers alike. In the area of education, we are evaluating the many worldwide programs used with much success abroad—primarily in Europe—for inclusion in our U.S. product offering.

We plan to have the ability to train our dealers, not only in the use of Commodore equipment, but also in applications software endorsed by Commodore and in the marketing and sales techniques needed to address the business, education and other important markets.

A major effort will also be put forth in the area of documentation. It is our plan to offer the highest-quality documentation, not only on specific products and what they do, but also on the application of those products. As one example, we're already including a 430-page book from Osborne/McGraw-Hill with every computer. Beyond this, you can expect to see an improvement in our *PET User Club* newsletter, better advertising and more involvement from Commodore in various "computer awareness projects."

How would you describe the small computer market—now and in the future?

This market, originally dominated by the hobbyist and experimenter, has now swung in favor of the business/professional user. This is closely followed by the educational market, where, in fact, there exists a vast reservoir of applications software for Commodore systems. The home and hobbyist market continues strong and has suggested the requirement for a new lower-cost computer.

The home computer market, as it's currently being served by products available from the major manufacturers, is not growing at the forecasted rate. At one time the home/hobbyist market was driven by the experimenter's interest in computer hardware and his tenacity in gaining access to the earliest systems on the market. Enter the personal computer. I think with the announcement of our next "new generation" personal computer, Commodore will once again be a pioneer and driving force in a new home computer market boom.

How has your overall marketing strategy changed?

We plan to "systematize the systems division" by stressing the importance of printers, floppies, educational materials and accessories, as well as CPUs. This requires better control of manufacturing and improved availability of peripherals, combined with a strong and aggressive applications software program, automation of our order processing system and more advanced sales order entry controls—all of which are being implemented.

A number of other changes have occurred in our marketing strategy. We'll be placing increased emphasis on business applications, for example. Commodore is currently evaluating several business software packages so we can offer a complete accounting capability to small-business first-time users. In addition, we'll be looking into the areas of cost accounting, budgeting and financial forecasting.

We've already had substantial success marketing Commodore computer systems with word-processing software (WORDPRO). The trend toward using computers for both word processing and data processing is inevitable, and we plan to be in that market with better and more sophisticated products in the coming year.

The availability of the IEEE interface on our computers lets us pay more attention to the professional and process control markets. In these areas, Commodore computers are excellent "workhorses." With the cost of microcomputers coming down and their capabilities going up, we see this as a large and growing market of continuing opportunity.

Our marketing strategy is also certainly changing with the attention we're devoting to vertical markets. We will shortly be announcing a new educational sales group that will concentrate on the sale of equipment, software and solutions to educators. Our intention is to provide educational institutions with "single-stop shopping" for hardware, software and support. We are investigating other marketing plans, which will be announced as they begin to mature.

Are you still selling most of your computers outside the U.S.?

Yes, but we're beginning to bring some of the procedures used in other parts of the world—notably in the United Kingdom—into the U.S. organization. In closing out fiscal year 1980, which ended June 30, Commodore is in the enviable position of being able to devote substantial resources not only to the international market, but also to the U.S. market. We plan to capitalize on our successful experience abroad to really excite an explosive U.S. marketplace.

Do you think Japan will steal the computer market like they did the color TV market in the U.S.?

Several large Japanese firms are already attempting to enter the U.S. marketplace with small personal computers. This is a topic of concern, not only among computer companies, but for Americans in general. However, I believe that despite their relatively lower labor costs—and, in some cases, well-established U.S. retail outlets—Japanese companies will have to price their products higher than U.S. products and will have a problem setting up a large-scale service organization. It is inevitable that Japanese electronics firms will enter the U.S. computer market, but I feel that large, well-established American computer manufacturers such as Commodore will not only survive but prevail.

What do you see for the future?

In an industry that has exploded in just a few short years, it's hard enough keeping up with the past and present without trying to forecast the future. But if I had to predict what's coming, I'd guess that the price of computers will continue to come down. The introduction of bubble memory and other high-speed low-cost mass storage media will bring about significant cost reductions in computer hardware, along with expanded capacity.

For the past several years, applications software has been the driving force behind the selection of all but the simplest computer systems, so I feel that improved applications software and vertically oriented support teams will be the key to manufacturers' success and user satisfaction in the coming months and years.

I think computers will become more portable, that telecomputing will begin to come into the living room and home computer use will expand enormously as computer-literate students begin to graduate and as the public in general becomes more accustomed to the concept of computers and learns more about what they can do.

Most important, I feel that better applications software will begin to make computers more "friendly" to first-time users in all markets, and will help to make the small computer as common in our homes and offices as telephones and television sets. ■

Write Self-Modifying PET Programs

Easy way to store small amounts of data.

Robert W. Baker
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Have a program that needs to store a small amount of data each time you run the program? Normally, you would use a cassette tape data file or put the information into DATA statements within the body of the program. Tape files are slow and inconvenient when dealing with only a small amount of data. Using DATA statements within the program is the most practical solution, but it usually requires editing the program to update the data.

Once you know how a BASIC program line is stored in memory, it's a simple matter to convert the data to a string of ASCII characters and poke them into a DATA statement. For example, the Commodore PET stores each program line as

- 2-byte link address: pointer to the next line
- 2-byte line number: program line number stored as a 2-byte binary number
- program line: the BASIC program line with all BASIC keywords (commands, functions, etc.) stored as 1-byte tokens
- 1-byte end of line: a zero byte to indicate the end of the line

In addition, a 2-byte pointer in low memory (RAM) indicates the starting address of the first line of the program. The 2-byte link of the first line usually starts at location 1025 (decimal), so the first character of the first line would normally be at location 1029. Assuming you put your DATA statement at the start of the program to make it easy to locate, location 1029 would contain the DATA token and your data would start at location 1030.

Application

The program listing keeps track of an individual's bowling average, along with data on high scores. I wrote it for an 8K Commodore PET. Line 10 initially contains dummy data for the information to be retained. The information is read from the DATA statement by line 40 and assigned to several variables:

P—total pin count
G—total number of games
D—number of individual games above the fixed game limit (GL)
S—number of series totals above the fixed series limit (SL)
HG—highest individual game score
HS—highest series total

A series of games is the number of games specified by the value of N in line 20, which is normally 3.

The user enters his new game scores for a particular night (lines 100–160) while the series total is computed and the games and series are checked against the high scores and limits. The program displays new data computed or found (lines 230–400) and then saves the new data in lines 410 through 460 using the subroutine starting at line 800 to poke the information into the DATA statement in line 10. This subroutine uses three variables to know what and where to save the data:

X—data to be saved
L—maximum length of data field (number of digits)
Y—starting memory location where data is to be poked

Line 800 adds 100000 to the data and converts it to a text string. This provides a string representation of the data with known length and greater than the maximum length data field to be saved. It has the added advantage of providing leading zeros for the number being stored. Line 820 converts each character to its ASCII value and pokes it into the DATA statement of line 10. Only the number of digits specified by L are saved, and they correspond to the rightmost L characters created in X$.

After all the data is saved, the length of the data field (plus one for the separating

Simple BASIC program listing.

```
10 DATA00000,000,000,000,000,0000
20 GL=200:SL=600:N=3
30 PRINT"█"TAB(11)"█BOWLING RECORDS
40 READ P,G,D,S,HG,HS
100 PRINT"██GAME SCORES (1 -"N"█) =██
110 T=0:FOR X=1 TO N:INPUT GS(X)
120 T=T+GS(X)
130 IF GS(X) >= GL THEN D=D+1
150 IF GS(X) >HG THEN HG=GS(X)
160 NEXT:IF T >= SL THEN S=S+1
170 IF T > HS THEN HS=T
```

```
 230 IF G<1 THEN PRINT"FIRST ENTRY":GO
TO 310
 300 PRINT"OLD AVERAGE";TAB(15);INT(P
/G)
 310 P=P+T:G=G+N:PRINT"SERIES TOTAL";TA
B(15);T
 315 PRINT"NIGHT AVERAGE";TAB(15);INT(T/
N)
 320 PRINT"TOTAL PINS";TAB(15);P
 330 PRINT"# OF GAMES";TAB(15);G
 340 PRINT"NEW AVERAGE";TAB(15);INT(P
/G)
 345 PRINT"────────────────────────"
 350 PRINT"HIGH GAME";TAB(15);HG
 360 PRINT"      SERIES";TAB(15);HS
 370 PRINT:PRINTGL"GAMES";TAB(15);D
 380 PRINTSL"SERIES";TAB(15);S
 400 PRINT"────────────────────────"
 410 L=5:Y=1030:X=P:GOSUB 800
 420 L=3:X=G:GOSUB 800
 430 X=D:GOSUB 800
 440 X=S:GOSUB 800
 450 X=HG:GOSUB 800
 460 L=4:X=HS:GOSUB 800
 600 PRINT"REWIND TAPE AND SAVE PROGRAM
 TO RETAIN  NEW RECORDS!":END
 800 X$=STR$(X+100000)
 810 FOR T=0 TO L-1
 820 POKE Y+T,ASC(MID$(X$,8-L+T,1))
 830 NEXT:Y=Y+L+1:RETURN
```

comma in the DATA statement) is added to the memory pointer (Y) to set the value for the next time the subroutine is called. Assuming the scores 212, 157 and 174 were entered when the program was run, line 10 would contain the following if listed before saving the program:

10 DATA0543,003,001,000,212,0543

The user just runs the program, types in the new data to be added or saveo and then saves the entire program when done. He doesn't have to know anything about the internals of the program or even what a DATA statement is. On an 8K PET, this entire program only takes about 20 or 30 seconds to load or save.

When using this method, just remember that the DATA statements must be preset with "dummy," or initial, data to reserve space for the actual data to be saved when run. Also, the DATA statements must not change position in memory or else you will have to change the address to poke data into. The subroutine is only intended as an example in using this method of saving data, since it will not work as coded for negative values or numbers greater than five digits.

This program will work just as easily for alphanumeric data in strings. Also, the DATA statements need not be located at the start of the program, just as long as you know where to poke the data. ■

Memory Expansion Candidates

Simple chip replacement is all it takes to add 16K to some PETs.

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Many owners of the 16K PET probably wish they had bought the full 32K system. Fortunately, some of you may still be able to convert—and in a matter of only a few minutes.

Some 16K PETs have sockets for their memory chips. If yours is one of them, you can simply remove the sixteen 4115 1K dynamic RAM chips, replace them with 4116 2K chips and rejumper the address lines. The conversion will cost you less than $200.

You start by unplugging your PET and removing the old 1K memory chips from their sockets. The sockets hold the chips firmly, so you'll need a tool. Make sure it's nonmetallic. Observe the usual CMOS handling precautions to avoid static charge damage to the chips or the computer. When you have removed the 4115s, simply replace them with the 4116s.

You must now change two sets of jumpers (Figs. 1 and 2). You will need to break three existing connections with a sharp, pointed tool and make three solder connections. In all, the minor surgery will take you 20 minutes or less.

After completing the reconfiguration, turn on the PET. The message 31743 BYTES FREE confirms a successful conversion.■

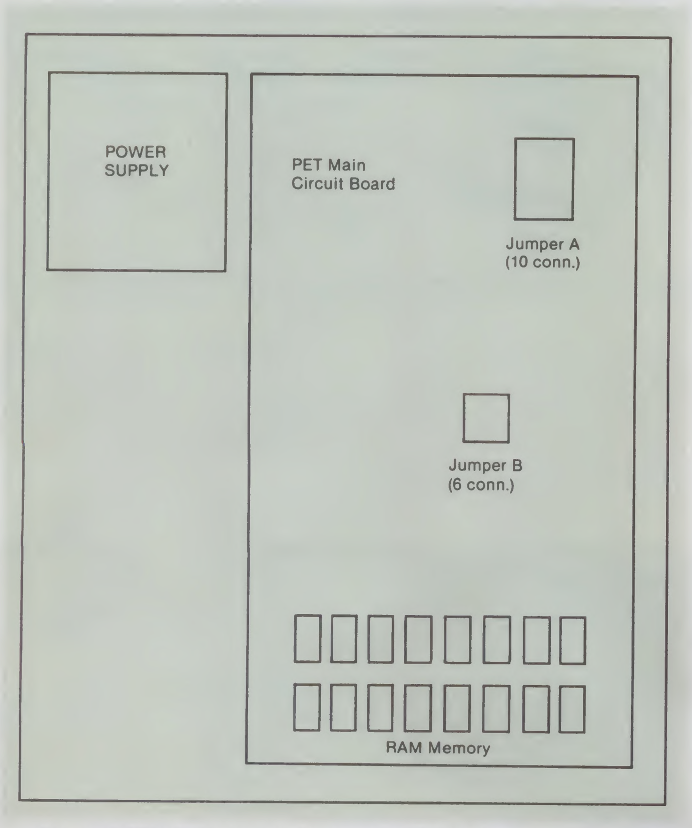


Fig. 1. PET circuit board, jumpers and RAM memory layout.

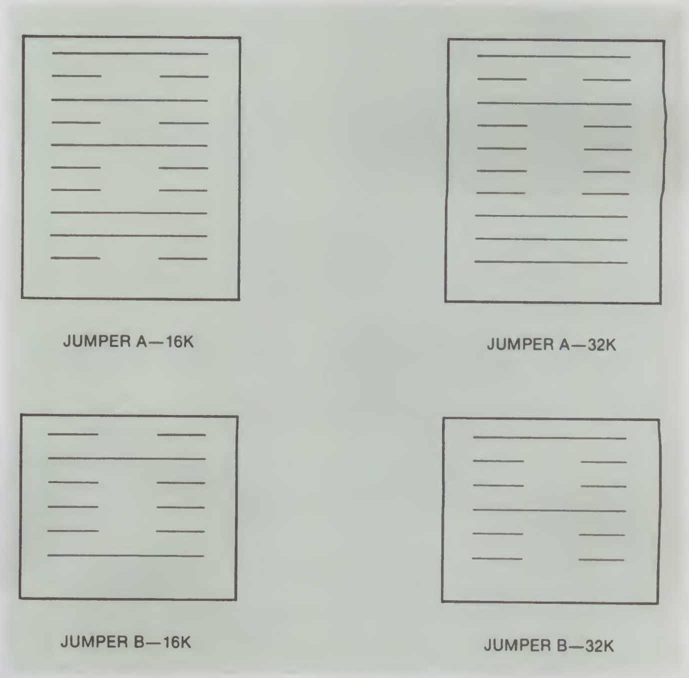
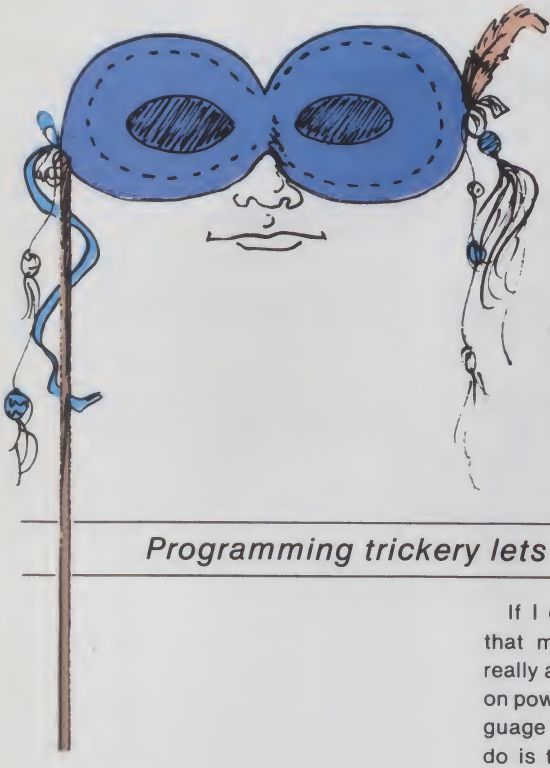


Fig. 2. Jumper configuration for 16K and 32K Commodore PET microcomputers.



PET Machine-Language Masquerade

Programming trickery lets machine language load and run from BASIC.

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Harrisburg, PA 17112

You can now load your machine-language programs directly from BASIC and execute them using the RUN command. Furthermore, you no longer need to include those POKE routines in your BASIC programs that have machine-language subroutines. You can also put your machine-language subroutines at the end of your BASIC program without fear of its being overwritten.

I discovered the trick to this when I was writing a 6502 simulator/machine-language tracer for debugging machine-language programs. I linked the routine to the end of Commodore's monitor by replacing the exit command, X, with my trace command, T, and then writing a new exit routine. Linking the two programs required my loading in the monitor, then loading in the tracer, then altering the monitor to form the link-up.

I realized it would be simpler if I could fix the whole thing up first, then record it. I would not have to do this every time I wanted to use the simulator/tracer, but I could not use the monitor to load itself without having to load the old monitor first anyway. I thought it was all over. Then I thought again.

If I could make the PET's BASIC think that my machine-language program was really a BASIC program, then I could load it on power-up. That's where the machine-language masquerade comes in. All you must do is tell the PET that your machine-language routine is just another BASIC program, and it will believe you and load it like any other BASIC program. Depending on whether your routine is a program in itself or a subroutine, you have two different ways of saving and loading machine language as BASIC.

For Stand-alone Machine-Language Routines

If you do not want the program in low memory (starting from 040F to 1000), you can use a BASIC POKE routine in low memory to put it in high memory. If you want the program to reside below 1000, you should POKE in the higher part of the program with a POKE routine. Then erase the POKE routine and use 1INPUTX: POKEI,X:I = I + 1: GOTO1 to POKE the rest of the program in (down to about 0418 hex).

Do not use any spaces between any letters. Say I = 1060 is the start of your program. Type RUN. Do not set I below 1050—if your program starts between 040F and 0417, you have to POKE these locations using direct BASIC commands after you are through with the higher portion of the program. If you have already written the program and have a BASIC loader and DATA routine, and you do not wish to change it, just use that program to POKE it in. If the program is in the second cassette buffer, you will have to rewrite the routine to start in the BASIC RAM area.

Your program is now in memory, and you want to save it as a BASIC program. Delete your POKE routine—you have no more use for it anymore—and type 10 SYS (number). Number is the decimal address of the start of your machine-language program. This line uses memory up to 040E or 040F hex, depending on whether the start of your program is a four- or five-digit number. This allows you to put your programs as low as 040F hex if you POKE in locations 040F to 0417 directly after you erase the one-line POKE routine from before.

To effect the masquerade, you must change a few locations in the PET to trick it into saving your machine language as BASIC. Just use direct POKE commands for this. The locations and their contents are shown in Table 1.

If your machine language resides from 1000 to 50F0, then 124 (and 229) are F0 + hex 1, or F1, which is 241 decimal; 125 (and 230) are 50 hex, or 80 decimal.

Now it's simple. Just "tell" your PET to SAVE "PROGRAM", and it will make a tape of your machine-language routine that you can load in right on power-up. No alterations are necessary before you load. Try it. Turn your PET off and on again and type LOAD. Better yet, use the LOAD/RUN feature, and your program will load and run right from BASIC.

For Machine-Language Subroutines

Load in your BASIC program. Delete the POKE routines and all the related DATA statements. To see where your program ends, type ?FRE(0) to find the number of free bytes you have. Be sure to clear all variables first if you have run the program. Subtract the number of free bytes from the number free at power-up (3071 in 4K PETs, 7167

in 8Ks, 15359 in 16Ks). Add 1024 to this number to get the address of the start of free space.

You can start your machine-language subroutines at this point if you want (you must move the routines if they are in the second cassette buffer) by changing the JMP and JSR addresses and other absolute memory references. You need not worry about the program being overwritten because the PET will think that the machine language is part of your BASIC program.

To leave your routine in high memory, load your complete BASIC program, run it to POKE in the machine language, then STOP it and delete the lines that constitute the POKE and DATA statements. To move your routine to the end of your BASIC program, save a copy of your BASIC program without the POKE and DATA statements (on a separate tape!) and delete the program in memory. Now use a POKE routine to put your machine-language subroutine into memory starting at the address you calculated. Reload your BASIC program—the one without the DATA and POKE statements. You should now be ready to SAVE your program. Set the locations in Table 1.

Address (decimal)	Data (decimal)
122	1
123	4
124	PC low of end of machine language + 1
125	PC high of end of machine language + 1
229	Same as 124
230	Same as 125

Table 1.

Type in SAVE "PROGRAM", and your BASIC program and machine-language subroutine are saved as a BASIC program. You can load this program directly from BASIC on power-up, just as with the machine-language-only routine.

How the Masquerade Fools the PET

Locations 122 and 123 point to the start of the BASIC program in memory. They should be 1 and 4, respectively, on power-up, but set them just in case. When you type RUN, the PET looks at locations 122 and 123 to find out where to start executing BASIC. You need the SYS (number) command as a BASIC line in your machine-language-only program to give the PET some BASIC to execute.

Locations 124 and 125 set the end of BASIC in memory so the PET knows where the program ends. Setting this to point at the end of your machine-language code makes the PET think it is BASIC. It will not try to execute your code as BASIC, however, because the PET sets a special trigger at the end of each entered BASIC line so that it ends up at the end of the last BASIC line. This trigger, double zeros after the end-of-line zero, keeps the PET from continuing through and trying to execute data or variables, or, in this case, machine-language code.

Locations 229 and 230 tell the PET to put this end-of-program address on the tape header so that the whole program is saved, machine language and all.

You now have a machine-language program (or BASIC and machine-language program) on tape that will load from BASIC on power-up. Just type RUN and away it goes —immediately—no waiting for a loader routine to execute. The machine-language code is protected from harm, and it doesn't have to be in the second cassette buffer. So come to the masquerade, and just chase away those BASIC-loader-blues. ■

Add a Reset Button to Any PET

Computer cowboys can now corral those runaway routines and still preserve programs in memory.

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I recently added a reset button to my 8K PET computer. Even though reset wipes out all BASIC programs in memory, page three, the second cassette buffer, is left intact. It works for me because all my resets were due to runaway machine-language programs in the second cassette buffer.

Now I have a new, larger PET. Following a hint in the *Commodore PET Users Club Newsletter,* I have a better reset button, able to recover from almost any crash with BASIC and data intact.

Installation

Here are the steps to installing a button on any PET.

Either epoxy-glue a switch to the case of the PET or drill a small hole in the case for one. In either case, place it where you can reach it, but not accidentally. (If you drill the case, back up the hole with tape or a piece of cloth to catch all the metal chips. If any escape, be sure not to leave them inside the case to cause grounding. Using a double-insulated drill is also kinder to PET's innards.)

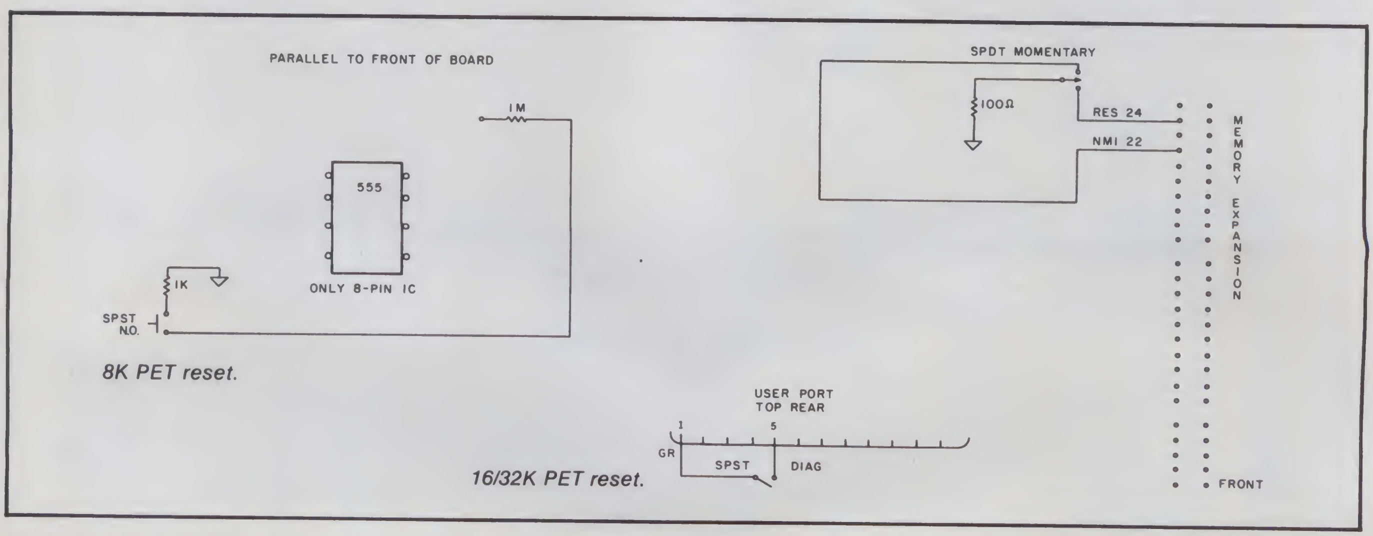
Ground one lead of your switch to the case of the PET through a resistor. For 8K PETs, use either lead of a single-pole single-throw normally-open push button and a 1000 ohm resistor. For 16/32K PETs, use the center lead of a single-pole double-throw switch that is momentary in both directions and a smaller resistor, perhaps 100 ohms. (York Electronic Stores carry the double-throw momentary switch.)

Solder the other leads from your switch to wires long enough to get from your mounting location to any part of the main board on the PET.

Solder miniature test clips to the other ends of your wires. On 8K PETs, clip the wire to the 1 megohm resistor (brown-black-green-gold) behind and to the right of the only 8-pin integrated circuit on the main board. This resistor lies parallel to the front of the main board, and you will make your attachment to the end furthest from the 8-pin IC.

On 16/32K PETs, clip one test clip to the 24th pin (RES) back from the front of the PET on the front memory expansion connector, on the side nearest the center of the main board. The other clip goes on the 22nd pin (NMI) from the front, same side.

Try it out. Turn on the PET and push the reset button. You should see the screen blank and the Commodore message come up. If you have the 16/32K version and push the switch to the NMI position, you will see the cursor and ready message move down



8K PET reset.

16/32K PET reset.

the screen.

For a real test, try crashing the PET with a system command (sys7700, when there's no program at 7700). Hit the reset button and watch the PET come back. 16/32K users will want to try the non-maskable interrupt before the reset to preserve any BASIC programs in memory.

16/32K users can take the process a step further by wiring a single-pole single-throw slide switch between pins 1 and 5 on the user port. Pin 5 is the diagnostic sense line. If it is grounded (through pin 1) when reset is applied, the PET will go to the monitor instead of a reset. This needs to be on a switch and not permanent, because the PET will jump to the monitor on power-up if the diagnostic line is grounded.

This last option is valuable because it will give you control of the PET, even when NMI fails to, and it will still preserve BASIC and data in many cases.

If you use the reset/diagnostic switch to capture a runaway program, you will immediately need to do two more things. First, type a semicolon (;), followed by a carriage return. Second, move the cursor up to the stack pointer part of the monitor register display on the screen. Change the hex digits under SP to F8 and hit the carriage return again. These two changes restore your monitor and BASIC to normal operation, with data preserved intact in most cases. (The exception would be if the runaway zapped those particular addresses.)

For a $5 investment, this may be the most cost-effective gift you can give your PET this year. ■

Credits

J. R. Kinnard, *PET User Notes*, issue six, for the reset location on 8K PETs.

J. Feagans, *Commodore PET User Club Newsletter*, issue three, for the hint on the reset powers of the new ROMs.

Jim Butterfield, *Compute*, issue one, for the changes to the monitor after using the reset/diagnostic switch combination.

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PM-8	MCM68764	33.00

Optimal Technology, Inc.
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Phone (804) 973-5482 ✓29

The Phantom Tape Drive

File handling becomes easier when PET thinks you've attached a second cassette.

Karen V. Conover
Tiger Trail East
Carmel, NY 10512

Like many PET owners, I sometimes longed for the ability to update data files. A disk system that would allow instant access to any record in the file would be nice.

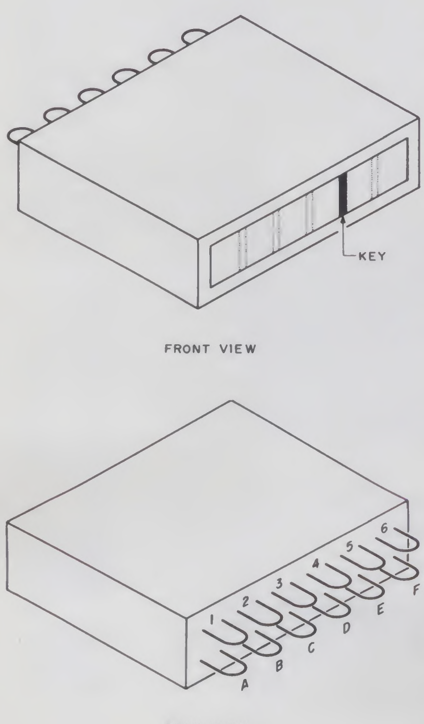

Fig. 1. Edge connector.

I even thought of owning a second cassette drive to hook into my PET. I could still have update capability by reading from one file on one drive and writing to another file on the second drive.

How could I have all of this without the $1200 + it would require?

By creating a phantom second cassette drive. The cost is $2.

The secret of the phantom drive is to tell the PET to use the built-in tape drive as tape 1 some times, and as tape 2 at other times.

The inconvenience is that you, the operator, must remove and insert input and output tapes into the built-in cassette drive as indicated by the PET.

The $2 cost is for a cassette port connector.

An edge connector, a switch and some wire are all you need to create your phantom. The switch will be the most difficult part to find. You must be able to switch three connections in two positions. This requires a 3PDT switch. I didn't have one, so I used two DPDT switches from my husband's junk box.

Step 1. Cut three lengths of wire, long enough to reach from the second cassette port (rear of PET) around to where the phantom control box will be located. (I assume that shielded cable or twisted wire pairs would be best; I just used regular hookup wire, which works fine.) I strongly suggest using three different colors of wire. This reduces the chance of hooking up the right wire to the wrong place.

Cut two more sets of three wires (same colors as above), long enough to reach from the first cassette port (inside PET) to where the phantom control box will be located.

You should now have three sets of three wires each—one long and two short sets. To keep things neat, bundle each set into a cable by wrapping it every six inches or so; I used masking tape.

Solder one end of the long set of wires to the top set of lugs on the edge connector (Fig. 1). You determine the top set of lugs by turning the connector so the solder lugs are towards you, and then flipping it so that the key in the face of the connector is on your left (my connector had numbers 1-6 on the top and letters A-F on the bottom). The wires should be soldered to lugs 3, 4 and 6.

You might want to put heat-shrinkable tubing or small pieces of tape around each connection after soldering to prevent any accidental shorts.

Step 2. Be brave; this step requires some minor surgery on your PET.

Open up your PET and locate the first cassette I/O port on the main logic board (Fig. 2).

Write down the color of *the wire in the*

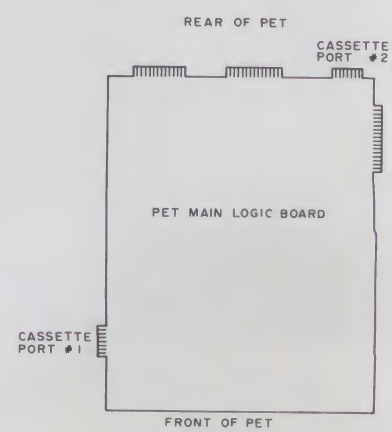

Fig. 2. Port locations.

tape drive cable that goes to each of the pins on the cassette port via the connector. (Mine were as indicated in Fig. 3.) Note that two wires are connected to the GND position (pin 1).

Disconnect the connector from the PET board and cut the connector off, leaving about one inch of cable attached to the connector.

Strip a little insulation off the end of each wire. Do this for the now connector-less tape drive cable and for the wires in the short cable still attached to the connector.

Step 3. Connect, solder and insulate one end of each set of short wires from step 1 to each part of the separated tape drive cable from step 2 (Fig. 3).

Make sure that the same color wire of each set is connected to the same position, as was done for the long set in step 1.

The color coding of your wires should be consistent with their functions. Each of your red wires should connect to "sense," one to the tape drive cable sense wire and one to the sense slots on each of the connectors (Fig. 3).

Note that the wires for GND, +5 and WRITE (pins 1, 2 and 5) are simply reconnected between the cassette drive cable and the port 1 connector.

If you are careful when cutting the cable in step 2 above, these wires do not even have to be cut.

Step 4. Connect the three sets of wires to the switches as shown in Fig. 4. Connect the read, sense and motor lines to a separate pole of the switches. The wires from the second cassette port go to one side of the switch; those from the first cassette port go to the other side of the switch. The wires from the tape drive cable go to the middle lugs of the switches.

Mount your switches in a box. I used an *old wristwatch box. Label the* box for drive 1 and drive 2.

Step 5. Plug the connectors onto their respective ports on the PET main logic board.

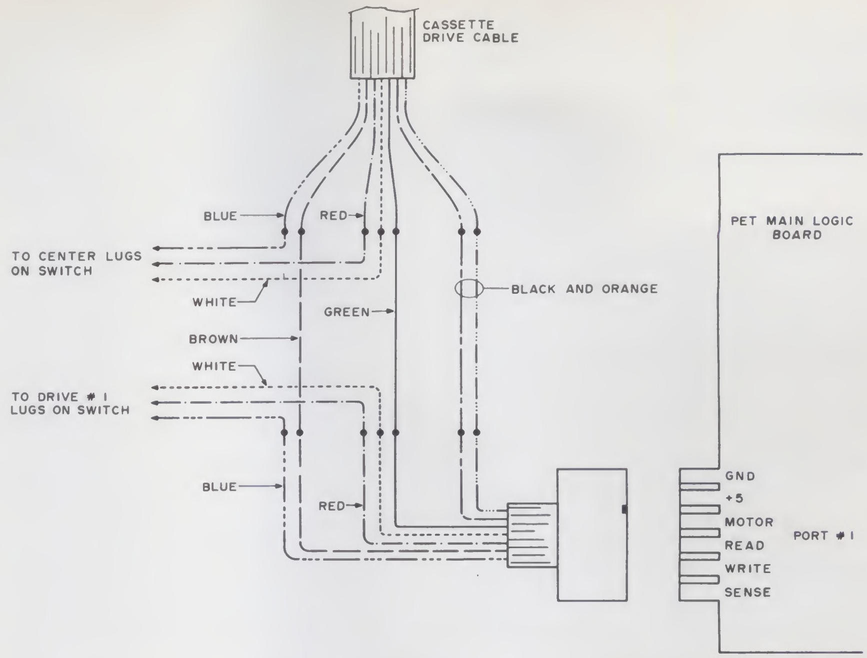

Fig. 3. Details for steps 2 and 3 (cable cut, wiring, colors and connection).

The phantom tape drive is now ready to use.

Using the Phantom Tape Drive

The phantom drive is most useful when you are updating a file or are copying data from one file to another. To use it, you simply insert the proper tape and throw the switch whenever PET prompts you.

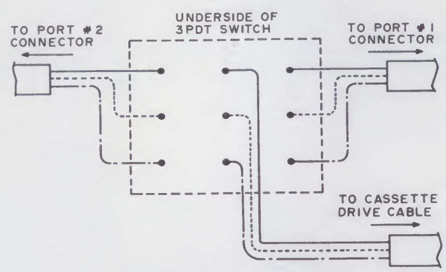

Fig. 4. Switch connections.

The amount of cassette-tape handling that must be done depends on how frequently your program alternates I/O commands between tape drives 1 and 2. If your program reads a byte at a time from one file and then writes it out to another, you will have to swap tapes every 192 bytes (length of PET's I/O buffer).

Programs can be either written or modified to reduce the amount of tape-swapping required; do mass reads and writes of data temporarily and store it in memory, instead of doing a read-a-byte, write-a-byte kind of I/O.

A tape swap for every 192 bytes of data processed is the worst case required. This will only occur in programs where logical records are less than 192 bytes long and are processed serially.

Don't worry about writing on the wrong tape. PET will prompt you to press play (or

play and record) every time it switches to and from the phantom tape drive. This prompt is your signal to swap tapes, flip the switches on the phantom control box and then press the buttons on the tape drive. The PET will not start the tape drive until the switch is flipped and the phantom drive is activated/deactivated.

For example, if your program is reading from tape drive 1, the switch on the phantom control box must be in the drive 1 position before the PET will start the tape drive moving. When the phantom is set at drive 1 and your program wants to write to tape drive 2, even though the play button is depressed, PET will not start the tape moving until the phantom switch is placed in the drive 2 position. This allows you to remove the tape being read and insert the one to be written on. You then switch the phantom to the drive 2 position, press play and record, and the writing to the phantom tape drive continues.

Notes

If you use more than one switch, as I did, make sure that you flip all of them when you are activating/deactivating the phantom.

If you do not want to sever the tape drive cable (step 2), you can build a small interface card to which you attach one set of the short wires on one end and plug the other end into the connector on the end of the tape drive cable. You must then buy another connector to plug into the first casette port. (See Fig. 5 for this arrangement.)

The +5, GND and WRITE lines for the two cassette ports are tied together in the PET and do not have to be brought out to the phantom control box. They still have to be connected between the main logic board (at the cassette port) and the cassette drive (via the cassette driver cable). ■

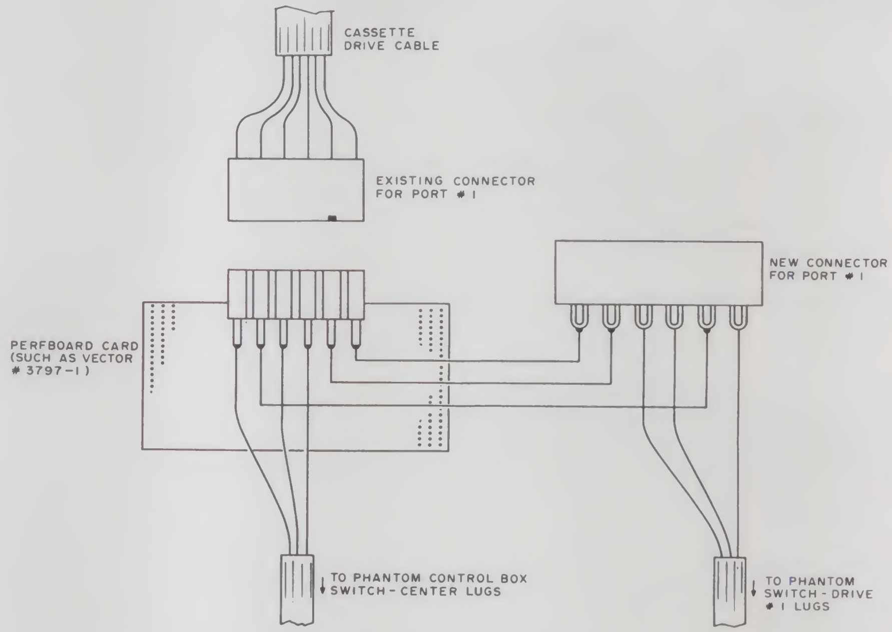

Fig. 5. Using an interface card.

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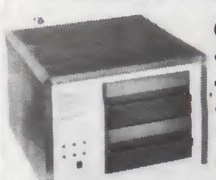

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Get Your PET On the IEEE 488 Bus

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Gregory Yob
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Commodore's printer and disk use the secondary addresses to control special functions within each device. The secondary address extends the range of allowable addresses on the IEEE 488 bus and is included after the LISTEN or TALK address with ATN made true. Most IEEE devices do not use secondary addresses.

The secondary address permits the device to distinguish between data transfers (for example, file I/O via the disk) and command sequences (for example, to initialize a new disk). The following is a brief summary of the secondary addresses used by Commodore's devices.

PET Printer.

0—Normal printing. The printer accepts characters and prints them as received.

1—Formatted printing. The characters are accepted and rearranged according to an internally stored format specification.

2—Format specification. The characters specifying the format to be used are accepted by the printer.

3—Pagination control. Accepts a number indicating the number of lines per page.

4—Control of diagnostic messages. If desired, diagnostic messages will be printed when errors are found. For example, if a number overflows its format, a message indicating this will be printed. This secondary address controls the options to use this feature.

5—Load programmable character. The printer accepts bytes that specify the dot matrix for one programmable character.

PET Disk.

2 to 14—Disk "channels" data transfers. The PET disk can have from zero to five files open at once. Each file is defined with an OPEN statement of the form:

OPEN (Log Addr), (Device Addr), (Channel Number), (Command String)

The channel number is a secondary address in the range of 2 to 14. The command string specifies the file type and drive. For example, "0,FILEONE, SEQ, WRITE" means open the file named FILEONE on drive 0 as a sequential file for write only access.

15—Disk command channel. A variety of commands to the disk is sent via PRINT# to a file opened to the secondary address of 15. The disk can also send error and diagnostic messages to the PET through this channel.

Though it is possible to control complex devices in this manner, these methods can become awkward and clumsy if many data transfers are needed, as is the case for disks and printers. Commodore chose this method to avoid having to modify or extend the PET's BASIC.

Ironically, Commodore now offers a machine-language program, WEDGE, which functions as an extension to BASIC for control of the PET Disk.

Two Examples

In most applications of IEEE instruments, your task will extend beyond communicating with the device. Once communications with the device are established, there remains the conversion of the data to a form usable by people or some other instrument that uses a different form of data. Also, care should be taken to make human communications as pleasant as possible. If your application is in a production (that is, for daily use, and not as an occasional experiment), clarity and reliability are important.

Two BASIC programs, which illustrate how the HP Clock and the HP Signal Source might be used in real-life situations, follow. They are presented here as examples of programming style with the IEEE 488.

Example 1: The HP Clock

Part 1 (*Microcomputing*, July 1980) describes the codes used for the HP Clock with the IEEE 488 bus. Listing 1 interacts with the HP clock in a "human-workable" form. Let's first take a look at how the program is seen from the outside (often called "human engineering" or "the user interface").

When the program is RUN, the following message appears on the screen:

```
HP CLOCK PROGRAM
PRESS ANY KEY WHEN YOU HAVE THE
CLOCK CONNECTED VIA THE IEEE 488
AND THE POWER ON.
```

This reminds the user to connect the clock on the bus and turn on the clock's power. If the PET tries to address a device that isn't connected or turned on, the ?DEVICE NOT PRESENT error message will appear and stop the program. Unfortunately, there is no graceful way to prevent this and keep the program running (some versions of BASIC have error traps; i.e., ON ERROR 5 GOTO . . .).

After you press a key, the request appears:

Listing 1. HP Clock program.

```
10 REM NICE HP CLOCK PROGRAM
20 PRINT"clr HP CLOCK PROGRAM"
30 PRINT"dn dn PRESS ANY KEY WHEN YOU HAVE THE
40 PRINT"CLOCK CONNECTED VIA THE IEEE 488
50 PRINT"AND THE POWER ON.
60 GET A$:IFA$="" THEN 60
70 REM INITIALIZE
80 DIM M$(12),M(12)
90 FOR J=1 TO 12:READ M$(J),M(J):NEXT
100 DATA JAN,31,FEB,28,MAR,31
110 DATA APR,30,MAY,31,JUN,30
120 DATA JUL,31,AUG,31,SEP,30
130 DATA OCT,31,NOV,20,DEC,31
140 INPUT"dn dn CLOCK'S DEVICE ADDRESS:",AD
150 IF AD<3 AND AD>16 THEN 170
160 PRINT"SORRY, LEGAL ADDRESSES ARE 4 - 15":GOTO 140
170 OPEN 1,AD
180 INPUT"dn dn IS THIS A LEAPYEAR";L$
190 IF LEFT$(L$,1)="Y" THEN M(2)=29:PRINT"BE SURE TO SET
    THE CLOCK TO 366 DAYS"
200 REM TIME SETTING REQUEST
210 INPUT"dn dn SET THE TIME";L$
220 IF LEFT$(L$,1)="Y" THEN GOSUB 1000
230 REM DISPLAY TIME
240 GOSUB 2000
250 GOTO 210

1000 REM TIME SETTING ROUTINE
1010 PRINT"clr sp SET THE DATE"
1020 PRINT"dn dn ENTER MONTH AND DAY IN THE FORM:
1030 PRINT"dn sp sp sp sp sp MONTH (SPACE) DAY
1040 PRINT"dn FOR EXAMPLE: sp sp MARCH 25
1050 INPUT"dn";MD$
1100 REM PARSE OUT MONTH & DAY
1110 M1$=LEFT$(MD$,3)
1120 FOR MN=1 TO 12
1130 IF M1$=M$(MN) THEN 1200
1140 NEXT MN: PRINT"dn dn I DON'T RECOGNIZE THE MONTH.
1150 PRINT"PLEASE SPELL THE MONTH COMPLETELY.
1160 PRINT"dn dn PRESS ANY KEY TO TRY AGAIN
1170 GETA$:IFA$="" THEN 1170
1180 GOTO 1010
1200 FOR J=1 TO LEN(MD$)
1210 IF MID$(MD$,J,1)=" sp " THEN 1300
1220 NEXT J
1230 PRINT"dn dn YOU FORGOT THE DAY
1240 GOTO 1160
1300 DY=VAL(MID$(MD$,J))
1310 IF DY>Ø AND DY<M(MN)+1 THEN 1400
1320 PRINT"dn dn YOUR DAY IS INCORRECT. IT MUST BE
1330 PRINT"FROM 1 TO"M(MN)"."
1340 GOTO 1160
1400 REM COMPUTE NUMBER OF DAY TICKS
1410 DT=Ø: IF MN=1 THEN 1430
1420 FOR J=1 TO MN-1: DT=DT+M(J):NEXT J
1430 DT=DT+DY-1
1450 REM DT IS # OF DAYS TO ADVANCE

1500 PRINT"clr sp SET THE TIME"
1505 PRINT"dn dn ENTER THE TIME IN THE FORM:
1510 PRINT"dn sp HOUR : MINUTE : SECOND : AM OR PM
1520 PRINT"dn FOR EXAMPLE: sp sp 2:25:36:PM"
1530 PRINT"dn";:GOSUB 4000
1600 REM PARSE OUT HOURS,MINS,SECS,AM?PM
1610 T$=T$+"XX":TH=VAL(T$)
1620 GOSUB 3000: IF PT>Ø THEN 1700
1630 PRINT"dn YOU DIDN'T INCLUDE EVERYTHING
1640 PRINT"PLEASE ENTER ALL FOUR ITEMS WITH
1650 PRINT"COLONS BETWEEN EACH OF THEM
1660 PRINT"dn PRESS ANY KEY TO TRY AGAIN
1670 GETA$:IFA$="" THEN 1670
1680 GOTO 1500
1700 T$=MID$(T$,PT+1)
1710 TM=VAL(T$)
1720 GOSUB 3000: IF PT=Ø THEN 1630
1730 T$=MID$(T$,PT+1)
1740 TS=VAL(T$)
1750 GOSUB 3000: IF PT = Ø THEN 1630
1760 T$=MID$(T$,PT+1,2)
1800 REM ERROR MESSAGES
1810 IF TH<1 OR TH>12 THEN PRINT"dn dn YOUR HOURS MUST
     BE FROM 1 TO 12":GOTO 1660
1820 IF TM<Ø OR TM>59 THEN PRINT"dn dn YOUR MINUTES
     MUST BE FROM Ø TO 59":GOTO 1660
1830 IF TS<Ø OR TS>59 THEN PRINT"dn dn YOUR SECONDS
     MUST BE FROM Ø TO 59":GOTO 1660
1840 IF T$="AM" OR T$="PM" THEN 1860
1850 PRINT"dn dn PLEASE USE AM OR PM ONLY":GOTO 1660
1860 REM AM/PM LOGIC
1870 IF T$="AM" AND TH=12 THEN TH=Ø
1880 IF T$="PM" AND TH<12 THEN TH=TH+12
1900 REM SET CLOCK AT LAST
1910 PRINT#1,"RP";
1920 IF DT>Ø THEN FOR J=1 TO DT:PRINT#1,"D";:NEXT
1930 IF TH>Ø THEN FOR J=1 TO TH:PRINT#1,"H";:NEXT
1940 IF TM>Ø THEN FOR J=1 TO TM:PRINT#1,"M";:NEXT
1950 IF TS>Ø THEN FOR J=1 TO TS:PRINT#1,"S";:NEXT
1960 PRINT#1,"T"
1970 RETURN

2000 REM DISPLAY TIME
2010 PRINT"clr sp sp sp sp sp THE CURRENT TIME IS
2020 PRINT"dn dn sp sp DATE:"
2030 PRINT"dn dn sp sp TIME:"
2040 PRINT"dn dn dn dn dn dn dn dn dn dn dn dn dn dn        (14 dn's)
        sp sp PRESS ANY KEY TO SET TIME
2050 GETA$:IFA$<>"" THEN RETURN
2060 REM FETCH TIME
2070 INPUT #1,T$
2080 IF LEFT$(T$,1)="?" THEN GOSUB 5000
2090 REM PARSE OUT PARTS
2100 T1=VAL(MID$(T$,1,2))
2110 T2=VAL(MID$(T$,3,2))
2120 T3=VAL(MID$(T$,5,2))
2130 T3$=MID$(T$,5,2)
2140 T4$=MID$(T$,7,2)
2150 T5$=MID$(T$,9,2)
2160 PRINT"hm dn dn dn rt rt rt rt rt rt rt rt rt"M$(T1);T2
2170 REM AM/PM CALCS
2180 T6$="AM"
2190 IF T3>11 THEN T6$="PM"
2200 IF T3>12 THEN T3=T3-12
2210 IF T3=Ø THEN T3=12
2220 T3$=RIGHT$(STR$(T3),2)
2250 PRINT"dn dn rt rt rt rt rt rt rt rt rt"
     T3$":"T4$":"T5$":"T6$
2500 GOTO 2050

3000 REM SCAN T$ FOR COLONS
3010 FOR PT=1 TO LEN(T$)
3020 IF MID$(T$,PT,1)=":" THEN RETURN
3030 NEXT PT
3040 PT=Ø: RETURN
4000 REM FETCH STRING VIA GET DUE TO
4010 REM FLAKEY PET INPUT STATEMENT
4015 T$=""
4020 GET A$: IF A$<>"" THEN 4100
4030 PRINT"rvs sp lft";:FOR J=1 TO 300: NEXT
4040 GET A$: IF A$<>"" THEN 4100
4050 PRINT"off sp lft";:FOR J=1 TO 300: NEXT
4060 GOTO 4020
4100 PRINT"off sp lft";
4110 IF A$=CHR$(13) THEN PRINT: RETURN
4120 PRINT A$;: T$=T$+A$: GOTO 4020

5000 PRINT"hm dn dn dn dn dn dn dn dn dn dn dn
     >>>>>>> sp TIME NEEDS TO BE SET sp<<<<<<<"
5010 PRINT"dn>>>>>>> sp DUE TO POWER FAILURE sp <<<<<<<"
5020 T$=MID$(T$,3):RETURN
```

CLOCK'S DEVICE ADDRESS;?

Now enter the address on the DIP switches for the device. If an unacceptable value, such as 16, is entered, the PET will respond with:

SORRY, LEGAL ADDRESSES ARE 4-15

and ask again. The best way to avoid problems is to forbid illegal values for inputs, tell the user that he has goofed and mention the correct range of values.

Once the *device address* is in, the PET asks:

IS THIS A LEAP YEAR?

If "YES" is entered, a reminder appears to set the clock accordingly.

BE SURE TO SET THE CLOCK TO 366 DAYS

The last request asks:

SET THE TIME?

If the user doesn't want to set the time, the screen clears and the date and time are shown:

THE CURRENT TIME IS
DATE: JAN 29
TIME: 7:02:54 PM

PRESS ANY KEY TO SET TIME

The time ticks away with the seconds changing the most rapidly. A different set of values will appear on the clock:

01 29   19 02 54

The program has translated from 24-hour time to normal AM/PM time and changed the month from a number to the month's name.

The HP clock will send a ? as the first time character if the clock has not been set since a loss of power. If you pull the plug on the clock and plug it in again, the program will stop with a ?DEVICE NOT PRESENT ERROR. When the program is RUN, the time will be displayed with the following in the space

between the time and the PRESS ANY KEY line:

>>>>>TIME NEEDS TO BE SET<<<<<
>>>>>DUE TO POWER FAILURE<<<<<

Now if you press a key, the SET THE TIME? request will reappear:

SET THE TIME? YES

The screen clears and will display:

SET THE DATE
ENTER MONTH AND DAY IN THE FORM:
MONTH (SPACE) DAY
FOR EXAMPLE: MARCH 25
? JANUARY 29

If the first three letters in the month are incorrect, the program will make you start over:

I DON'T RECOGNIZE THE MONTH.
PLEASE SPELL THE MONTH COMPLETELY.
PRESS ANY KEY TO TRY AGAIN.

If you missed the date, the PET says:

YOU FORGOT THE DAY
PRESS ANY KEY TO TRY AGAIN

If you enter an inappropriate date, such as JAN 45, the PET, will say:

YOUR DAY IS INCORRECT. IT MUST BE FROM 1 TO 31.

The program has the number of days for each month stored inside. If the month were February, the range 1 to 28 would have been shown instead.

Now that the date is entered correctly, the screen clears to let the time be entered.

SET THE TIME
ENTER TIME IN THE FORM:
HOUR : MINUTE : SECOND : AM OR PM
FOR EXAMPLE: 2:25:36:PM
7:19:25:PM (you enter this line)

The screen will flicker a bit, and then the time display will appear.

The PET won't correctly input a string with colons in it, so the entry here is "faked" to look like a normal INPUT line. Unfortunately, if you must INST or DEL to correct your line, the correction won't really be entered. This can be programmed around, but I didn't feel like doing it with an instrument on loan to me for a week. The subject of faking INPUT is an article in itself.

Again, there are some error messages to help and assist the user:

YOU DIDN'T INCLUDE EVERYTHING
PLEASE ENTER ALL FOUR ITEMS WITH COLONS BETWEEN EACH OF THEM
PRESS ANY KEY TO TRY AGAIN
YOUR HOURS MUST BE FROM 1 TO 12
YOUR MINUTES MUST BE FROM 0 TO 59
YOUR SECONDS MUST BE FROM 0 TO 59
PLEASE USE AM OR PM ONLY

Here, a bad entry only forces you to reenter the time. The date is OK, so why redo it?

Perhaps this example is extreme. In many situations it isn't worth the programming time to make a program completely convenient to use. As an idealist, I wrote it up to show what can be done if ease of use is required.

HP Clock BASIC Program Review (Listing 1)

Lines 10 to 60 announce the program and force the user to wait until he has made sure the HP Clock is attached to the PET's IEEE 488 and the power is turned on. DATA in lines 100 to 130 are placed in the months' names' array M$ and the months' lengths' array M.

Lines 140 to 170 request the HP Clock's address and check to see if the address is legal. Line 160 tells the user to try again and mentions the legal range as a hint. Lines 180 and 190 take care of the leap-year problem by changing the month length for February to 29 days and reminds the user to check the leap-year switch on the HP Clock.

In lines 200–220, the user is asked if the time is to be set (which must be done when the clock is first used), and a loop is entered in lines 240 and 250. Subroutine 1000 sets the time, and subroutine 2000 displays the time. The program will not leave subroutine 2000 until a key is pressed. Line 250 jumps to the time-change request as needed.

Setting the time in subroutine 1000 is a complicated job, requiring correctly entering the data. First, you must enter the month and day as explained in lines 1010 to 1040, which give an example of the expected format.

Line 1050 picks up the user's entry, and lines 1000 to 1180 take a look at the first three characters to see if they fit a month's name. Lines 1140 to 1180 take care of any mistake in the entry of a month's name.

Lines 1200 to 1220 scan the input string, MD$, until a space is found. This removes the remnants of the month's name and brings us up to the date digits. Failure to find a space means the day was forgotten, and the user is told to start all over.

Lines 1300 to 1340 check the day number with the number of days in the month M(MN). If everything is OK, lines 1400 to 1450 will figure out the value DT, which is used to send the correct number of Ds to the clock for date setting.

Now that we have the number of days from Jan. 1 (in the number DT), lines 1500 to 1530 will tell the user to enter the time in a familiar format—HH:MM:SS:AM or PM. Subroutine 4000 is used to enter the string T$ via the GET statement. In lines 1620 to 1850, the string T$ is snipped apart at the colons, and each part is examined for the correct range of values; subroutine 3000 looks for the colons, and lines 1680 to 1760 do the scissor-work. We eventually end up with the values TH, TM, TS and T$, for hours, minutes, seconds and AM/PM values.

Lines 1860 to 1880 adjust the hours, TH, according to the AM or PM value. Lines 1900 to 1970 set the HP Clock—first the clock is reset via "RP," and then the correct numbers of "D," "H," "M" and "S" are sent to set the time. Then "T" is sent to start the clock.

Subroutine 2000 sets up the screen in lines 2010 to 2060. Note that the GET in line 2050 only checks if a character was entered. If not, it will continue to line 2070. The HP Clock is accessed in line 2070, and line 2080 checks for "?." The "?" means the clock saw a power failure, and subroutine 5000 will warn of this event.

Lines 2100 to 2150 get the various parts of the HP Clock's message. T1 is the month number; T2 is the day number. Line 2160 displays the month and day values.

Lines 2170 to 2220 adjust the hours value, T3$, to reflect whether an AM or PM time is being shown. Then line 2250 prints the hours, minutes, seconds and AM/PM marker.

In subroutine 3000, PT is the position of the first colon found in the string T$.

Subroutine 4000 simulates a cursor and constructs T$ from the characters entered through GET A$. No editing is provided, so if you make an error, the entry must be repeated. A little more code could catch A$ = 20 (code for DEL) and give some limited editing (equivalent to back space or rubout on a terminal).

Subroutine 5000 puts the power failure message on the screen and strips the "?" from T$. This permits the display of time code to work correctly.

The astute programmer will note that no provision is made for bad messages from the HP clock (which might make the program fail in some cases). You should check the values T1, T2, T3, T3$, T4$ and T5$ for their legal values and make another attempt to read the time made in case of an error. In the event of several consecutive errors, the program should mention this to the user.

There are limits to how "failsafe" a program must be made. In many cases, malfunctions will not be critical, and it isn't worth the effort required to make the program survive the errors. I do not recommend the PET for any real-time control applications that may result in injury or loss of property in the event of the PET's failure!

Example 2: The HP 8165A Signal Source

Part 1 introduced the 8165A. Naturally, your interest will be with the devices that you have available, and the example shown here is a "laboratory application"; that is, a program similar to one you might want to build for your instrument.

Let's pretend that the response of a stereo *amplifier* needs to be tested in a production line. The frequencies and voltages to be tested are:

10 Hz,	Sine Wave,	1.000 volts
10 Hz,	Square Wave,	1.000 volts
20 Hz,	.....	
20 Hz,	.....	
50 Hz,		

Test sine wave and square wave responses at 1.000 volts for 10, 20, 50, 100 . . . up to 20 kHz.

The plan for a program is as follows:

1) Initialize. For example, open

```
10 PRINT"clr STEREO TEST PROGRAM
20 PRINT"dn dn BE SURE THE 8165 IS ON AND THAT
30 PRINT" THE IEEE 488 IS CONNECTED.
40 PRINT"dn REMEMBER THE ADDRESS FOR THE 8165
50 PRINT"MUST BE 8. PLEASE CHECK THIS.
60 GOSUB 1000
70 OPEN 1,8
80 REM SET UP 8165
90 PRINT#1,"FRQ1ØHZAMP1.ØØØVF1D2OD"
100 REM HOOK UP STEREO
110 PRINT"clr STEREO AMPLIFIER TEST"
120 PRINT"dn ATTACH THE NEW UNIT TO THE
130 PRINT"TEST STATION."
140 GOSUB 1000
200 REM PERFORM TEST
210 PRINT"clr >>>> TEST IN PROGRESS<<<< "
220 FOR L1=1 TO 4
230 FA=1Ø↑L1
240 FOR L2 = 1 TO 3
250 IF L2 = 1 THEN FR=FA/1ØØØ
260 IF L2 = 2 THEN FR=FA*2/1ØØØ
270 IF L2 = 3 THEN FR=FA*5/1ØØØ
275 IF FR >25 THEN 430
280 FOR W = 1 TO 2
290 IF W=1 THEN W$ = "SINE"
300 IF W=2 THEN W$ = "SQUARE"
310 REM SET 8165 UP
320 PRINT#1,"FRQ"STR$(FR)"KHZ"
330 IF W=1 THEN PRINT#1,"F1OE"             (letter F, numeral 1,
340 IF W=2 THEN PRINT#1,"F3OE"              letters OE)
350 REM SET TIMER & REPORT
360 T1 = TI                                 (tee one = tee eye)
370 PRINT"hm dn dn dn TEST AT:";
380 PRINT"sp sp FREQ:"FR*1ØØØ"sp sp"W$"sp sp sp"
390 IF TI - T1<6ØØ THEN 390
400 REM TURN 8165 OFF
410 PRINT#1,"OD"                            (letters OD)
420 NEXT W
430 NEXT L2
440 NEXT L1
450 REM TEST COMPLETE
460 PRINT"clr ****** TEST COMPLETED ******"
470 PRINT"dn dn REMOVE AMPLIFIER FROM TEST STATION"
480 GOSUB 1000
490 GOTO 110

1000 PRINT"dn dn PRESS ANY KEY WHEN READY"
1010 GETA$:IF A$="" THEN 1010
1020 RETURN
```

Listing 2. Stereo Test program.

the IEEE 488 file.

2) Tell the operator to hook up an amplifier

3) Start the test

4) Loop through the frequencies for each frequency

5) Loop through sine and square

6) Wait for 10 seconds before continuing

7) Report where the test is on the screen

8) End of both loops

9) Tell the operator the test is finished

10) Go to step 2

Listing 2 shows these steps in a BASIC program. From the user's point of view, when the program is RUN, the message below appears:

STEREO TEST PROGRAM

BE SURE THE 8165 IS ON AND THAT THE IEEE 488 IS CONNECTED.

REMEMBER THE ADDRESS FOR THE 8165 MUST BE 8. PLEASE CHECK THIS.

PRESS ANY KEY WHEN READY

This reminder ensures that the 8165 is properly connected, powered and addressed. The PET program won't work if these conditions aren't met.

Now it is time to test a unit. The screen clears (after a key is pressed) and displays:

STEREO AMPLIFIER TEST

ATTACH THE NEW UNIT TO THE TEST STATION.

PRESS ANY KEY WHEN READY

Now the test commences, with a report on the current frequency and waveform being used:

>>>>>TEST IN PROGRESS<<<<<

TEST AT: FREQ: 200 SQUARE (current freq & waveform)

After about two minutes (each frequency and waveform takes ten seconds), the screen clears and tells the user:

•••••TEST COMPLETED•••••

REMOVE AMPLIFIER FROM TEST STATION

PRESS ANY KEY WHEN READY

Now we are ready to perform another test. Look at the scope and notice that the output of the 8165 is turned off between tests and between mounting the new amplifiers. Though unimportant in this example, more serious equipment should always be set to a "safe" state when the operator has to handle the equipment.

Lines 10 to 60 in the BASIC code state the program's name and remind the user to check the address setting on the HP 8165. Subroutine 1000 waits for you to press a key.

Three nested loops are used to scan through the frequencies and waveforms. The L1 loop sets the frequency decade from the range 10–99 Hz to 10000–99999 Hz. The L2 loop is used to select between 1, 2 and 5 times the frequency selected by L1. W chooses between sine and square waves.

Lines 200 to 300 compute the frequency FR in two steps (FA is set to 10^{L1}, and FR is set to 1,2 or 5 times FA), and W$ is set to report sine or square. In line 275 the top value to be tested is 20000 Hz, so to terminate the loops requires a test of the frequency larger than 20000 Hz.

Instead of using 20000 for the test, I am using 25000. (If you look at the code, FA is in kilohertz, so the test is for 25.) Due to the PET's way of computing numbers, when L1 is 3 and L2 is 2, FA turns out to be a tiny amount over 20, which terminates the test too soon.

When testing for equality or differences, make sure the number in the PET is what you think it is. Most floating point numbers will be slightly (and unprintably) different than the value you want, so fudge accordingly.

Line 320 sends the correct command to the 8165 for frequency. Note that FR is sent as the string STR$(FR). This avoids the Cursor Right after the number, which could totally confuse the 8165. Lines 330 and 340 specify the waveshape by directly sending the correct set of characters to the 8165. "OE" turns the 8165 on.

Lines 350 to 390 print the test values and wait for 600 jiffies, or ten seconds. When they are finished, line 410 turns the 8165 off (this is a "safe" state; e.g., during hook-up, the test leads could be shorted).

Lines 450 to 490 announce the end of the test and tell the user to remove the stereo amplifier. Note that the 8165 is in the "off" state.

I will leave it to you to figure out how to use the HP clock to control the timing of the stereo test program (Listing 2, part 2) instead of the PET's internal clock. Another variation is to put up the time each test is run for logging purposes.

More "Gotchas"

Program bugs. When I was debugging the HP Clock program (see Listing 1), the days' count wouldn't come out right. Some months tended to have two or three too many days, while others ran short. For example, May 5 put May 11 on the clock, and February 10 showed February 7.

I first thought that the IEEE 488 device was miscounting characters. I checked by printing the number sent onto the screen. The error wasn't here.

The eventual source of the problem was that the routine that counted the total days in

Function	Old Pet (hex)	(dec)	New PET (hex)	(dec)
Send TALK (MTA)	F0B6	61622	F0B6	61622
Send LISTEN (MLA)	F0BA	61626	F0BA	61626
Send UNTALK	F17A	61818	F17F	61823
Send UNLISTEN	F17E	61822	F183	61827
Set ATN true and send character in accumulator	F0BC	61628	F0BC	61628
Send data character in accumulator••	F0F1	61681	F0EE	61678
Get data character in accumulator	F187	61831	F18C	61836
Flag byte	0222	545	00A5	165

••Set flag byte to FF (255) before calling this routine.

Table 1. PET IEEE ROM and RAM locations.

the previous months just added the same number each time. For May, it added 31 four times, and for February, it added 28 once!

Another bug came from the "hidden bits" in PET numbers. In the Stereo Test program (Listing 2), there was the following line:

```
IF FR>20 THEN....
```

The testing program stopped at 10 kHz instead of 20 kHz. When I printed FR, I got 20. FR was formed from the two computations:

```
FA = 10↑L1
FR = FA•2/1000
```

The PET's exponentiation operator isn't totally exact, so a few bits slipped through. The division didn't help, and FR ended up a slight amount over 20, which is enough to make the condition true. The cure was to test for more than 25 instead.

These errors are subtle. If you aren't a total expert on your PET, these are nearly impossible to find.

Using the PET ROM

Since the PET knows the IEEE bus, there have to be routines in the PET ROM that know how to work the bus. A year ago, some of my clients' requirements forced me to access the PET's ROM for the IEEE. (One had a machine that didn't like the PET's state between IEEE messages; the other wanted to know the PET's maximum IEEE transfer rate.)

Table 1 indicates the pertinent RAM and ROM locations for the PET IEEE routines. Use caution when working with these, as I have only been able to check the ones mentioned below. In one case, a routine sent a character at an apparent rate of 5000 characters/second! (The listener didn't see anything at all.) The routine in question took a look at the bus, decided the bus wasn't in a legal state and returned, instead of sending the character! If you have an accurate PET disassembly, here is a good place to use it.

Input from the IEEE Bus. This can be approached either from machine language or as a mix of machine language and BASIC. In all cases, the first step is to open a file to the bus via BASIC. (This must be done; make sure that only one file is open.)

The next step is to send a TALK to the device. From BASIC, this is a SYS(61622), and in machine language it is a JSR F0B6 (or 20 B6 F0).

To handshake a character in requires calling the machine language in ROM. Here's a catch: the character arrives in the A register. From BASIC, you must SYS to a short routine that performs JSR F187 and an STA (somewhere) (and RTS to get back). Then PEEK (somewhere) gets your character. The machine code in hexadecimal is 20 87 F1 8D xx xx 60. The xx xx is your "somewhere." The value from the IEEE bus is the complement of your character; that is, the 1's and 0's are exchanged.

Send to the IEEE Bus. Again, the first step is to open a file to

```
10 REM PET SERIAL OUTPUT
20 REM GREGORY YOB
30 PT = 826
40 READ BT: IF BT  0 THEN 60
50 POKE PT,BT: PT=PT+1: GOTO 40
60 DIM BD(6),RT(6)
70 FOR J=1 TO 6
80 READ BD(J),RT(J)
90 NEXT J
100 PRINT"clr SERIAL OUTPUT"
110 PRINT"dn PARITY"
120 PRINT"0=EVEN, 1=ODD, 2=MARK"
130 INPUT P
140 IF P=0 THEN 180
150 IF P=1 THEN 180
160 IF P=2 THEN P=255: GOTO 180
170 GOTO 110
180 POKE 994,P
190 PRINT"dn BAUD RATE"
200 INPUT BT
210 FOR J=1 TO 6
220 IF BT=BD(J) THEN 380
230 NEXT J
240 PRINT"RATES ARE:"
250 FOR J=1 TO 6: PRINT BD(J): NEXT
260 GOTO 190
380 POKE 995, RT(J)
390 PRINT"# TIMES TO REPEAT CHAR"
400 INPUT N
410 N=INT(N): IF N<Ø OR N>255 THEN 390
420 PRINT"PRESS ANY KEY TO SEND CHARS"
430 GET A$: IF A$+"" THEN 430
440 PRINT A$
450 POKE 997,N: POKE 992, ASC(A$)
460 SYS(826)
470 GOTO 420

1000 DATA 173,4,2,234,234,240,1
1010 DATA 96,173,64,232,41,64,240
1020 DATA 241,120,21,192,3,144,2
1030 DATA 88,96,32,98,3,32,153
1040 DATA 3,88,76,58,3,234,24
1050 DATA 173,224,3,96,234,169,0
1060 DATA 141,225,3,173,224,3,162
1070 DATA 1,160,0,24,74,144,5
1080 DATA 160,225,238,225,3,72,152
1090 DATA 157,240,3,104,232,224,8
1100 DATA 208,234,273,226,3,48,12
1110 DATA 240,3,238,225,3,173,225
1120 DATA 3,41,1,240,2,169,255
1130 DATA 157,240,3,96,162,255,232
1140 DATA 189,240,3,141,34,232,172
1150 DATA 227,3,173,0,64,173,0
1160 DATA 64,173,0,64,136,208,244
1170 DATA 234,236,228,3,208,228,96
1180 DATA 96,0,0,0,0,0,0
1190 DATA 0,24,173,229,3,208,2
1200 DATA 56,96,173,224,3,206,229
1210 DATA 3,96,0,0,0,0,0
1220 DATA 0,0,0,0,0,0,0
1230 DATA 0,0,0,0,0,65,2
1240 DATA 0,195,11,0,0,0,0
1250 DATA 0,0,0,0,0,0,0
1260 DATA 0,255,0,0,0,0,0
1270 DATA 255,0,255,255,0,0,0
1280 DATA 0,0
1300 DATA -1
1999 REM PARAMETERS FOR BAUD RATES
2000 DATA 9600,5,4800,11,2400,23
2010 DATA 1200,48,600,97,300,195
```

Listing 3. Serial output via the IEEE 488 bus port.

Listing 4. Serial output, machine-language assembly listing.

```
     This code was hand assembled and then patched - so the flow
isn't continuious and there are occasional NOPs that aren't needed.

                               ! Check SHIFT key
033A AD 04 02  SENSE    LDA SHIFT (0203)     read shift key location
     EA EA              NOP, NOP             (tis a patch)
     F0 01              BEQ GO (0342)
     60                 RTS                  back to'BASIC if SHIFT
                                              pressed
                        ! See if device is ready
0342 AD 40 E8  GO       LDA $E840            Get all PB2 lines from VIA
     29 40              AND #40              Mask NRFD bit
     F0 F1              BEQ SENSE (033A)     Wait if not ready

                        ! Set up PET for transmission of characters
                        !  Turn off interrupts
                        !  Get character
                        !   Set carry if no more characters
                        !  Set up Xmission table
                        !  Send character

0349 78                 SEI                   Interrupts off
034A 20 C0 03           JSR FETCH (03C0)      Fetch Character
                                              (Set up as a subroutine
                                               to let you "roll your own"
                                               routine)
     90 02              BCC GO1 (0351)
     58                 CLI                   Interrupts on. If Carry is
     60                 RTS                   set, no more chars to send.
                                              If you make your own FETCH,
                                              use this convention.

0351 20 62 03  GO1      JSR SETUP             Set up Xmit table for char in A
     20 49 03           JSR XMIT              Send char
     58                 CLI                   restore interrupts
     4C 3A 03           JMP SENSE             Look at SHIFT key again
     EA                 NOP                   (patch)

035C 18        FFETCH   CLC                   Dummy version of FETCH
     AD E0 03           LDA CHAR (03E0)       Test Char location
     60                 RTS
     EA                 NOP                   (guess)

                        ! Set up Xmission Table
0362 A9 00     SETUP    LDA #00
     8D E1 03           STA PARITY (03E1)   Initialize parity counter
     AD E0 03           LDA CHAR (03E0)     Get char
     A2 01              LDX #01             X reg counts 7 bits of char.
                        ! Shift char & if carry set, load FF into
                        ! Xmit table. If carry not set, load 00
                        ! (NOTE: Start & Stop bits are assumed preset
                        ! in Xmit table. Be sure this is so in your
                        ! program too.)

036C A0 00     SLOAD    LDY #00               Y holds 00 or FF for bit
     18                 CLC                     in char.
     4A                 LSR A                 Shift LSB into Carry
     90 05              BCC HOPPITY           Bit is zero
     EE E1 03           INC PARITY (03E1)     '1' bit adds to parity count
     48                 PHA                   Stuff A on stack
     98                 TYA                   Y to A
     9D F0 03           STA START,X           Put into Xmit table. I just
                                              love non-symmetrical
                                              instruction sets! (6502
                                              has no Y indexed addressing)
     68                 PLA                   Restore A from stack
     E8                 INX                   On to next bit
     E0 08              CPX #08               7 bits yet?
     D0 EA              BNE SLOAD (036C)      no, repeat

                        ! According to  option, set the parity
                        ! bit in the Xmit table

0382 AD E2 03           LDA POPTION (03E2)  Get option value
     30 0C              BMI MARK            MSB means MARK parity
     F0 03              BEQ EVEN            zero is EVEN
     EE E1 03           INC PARITY          Add 1 for odd parity
     AD E1 03  EVEN     LDA PARITY
     29 01              AND #01             LSB has parity in it
     F0 02              BEQ ZILCH           Save LDA #00 if A is 00
     A9 FF     MARK     LDA #FF
     9D F0 03  ZILCH    STA START,X         Put in Xmit table. X happens
     60                 RTS                 to be right value!

                        ! Send Character
0399 A2 FF     XMIT     LDX #FF             The next instruction
     E8        CONT     INX                    makes X zero.
     BD F0 03           LDA START,X         Get byte to send
     8D 22 E8           STA $E822           Put on IEEE DIO Lines (out)

                        ! Delay loop for baud rate
03A2 AC E3 03           LDY RATE (03E3)     Get countdown value
03A5 AD 00 40  AGAIN    LDA $0400           4 cycles of delay
     AD 00 40           LDA $0400              ditto
03AB AD 00 40           LDA $0400              ditto
```

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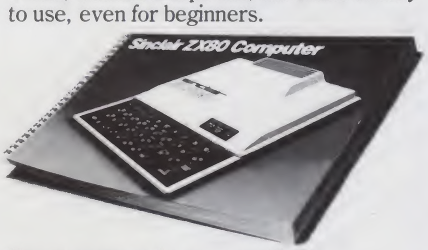

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```
     88                     DEY                  reduce countdown
     D0 E4                  BNE AGAIN (03A5)      keep going till count is zero
     EA                     NOP                  Successful branch takes 3
                                                  so this compensates to
                                                  make a 17 cycle per loop
                                                  delay
       EC E4 03             CPX BITCOUNT          Check number of bits to
                                                   be sent.
       D0 E4                BNE CONT              Do next bit
       60                   RTS

.......(some room here) .......

                            ! Fetch Character for real. Feel free to
                            ! make your own routine. Set carry bit when
                            ! out of characters.
03C0 18        FETCH        CLC                   Be sure to do this!
     AD E5 03               LDA CHCOUNT (03E5)    # chars to send
     D0 02                  BNE OK
     38                     SEC                   Set  carry, out of chars
     60                     RTS

     AD E0 03  OK           LDA CHAR              Get char - you might use
                                                  TAX & LDA CHAR,X here.
     CE E5 03               DEC CHCOUNT           decmt chars counter
     60                     RTS

....... (some room here) .......

                            ! Data Area

03E0 00        CHAR         ! Character to send. (Move elsewhere if you
                                want to send more than one)
03E1 00        PARITY       ! Parity Counter
03E2 00        POPTION      ! Parity Option. 0-even,1-odd,FF-mark
03E3 00        RATE         ! Initial countdown for baud rate. POKEd
                               by the BASIC program.
03E4 00        BITCOUNT     ! Number of bits to send (10 or 11 decimal)
03E5 00        CHCOUNT      ! Number of chars to send

....... (a gap again) ......

03F0 00        START        ! Start of Xmit table
03F1 00 00 00 00 00 00 00      ! Character, lsb first
03F8 00                     ! Parity bit
03F9 FF FF                  ! Stop bit(s)
```

the bus and be sure that only one file is open. Then, send the ATN LISTEN via SYS(61626). (In machine language, JSR F0BA, or 20 BA F0.) Now, put the complemented value into location $0222 with a POKE 546, CHARACTER.

The last step is to SYS (61681), which sends the character. In some cases, you will have to set a flag first by setting location $021D to $FF by POKE 541,255. I have used both methods with success.

The machine-language sequence is A9 FF 8D 1D 02 20 xx xx 8D 22 02 20 F1 F0 60. The 20 xx xx is a JSR to your routine at xx xx, which gets a character in the A register.

Both the input and the output will leave the device active on the bus. Make ATN true and send the UNL and UNT value to release the device.

The IEEE lines in the PET don't have to be used for the IEEE 488 bus. There are 12 easily used bits of parallel I/O that can be controlled with suitable PEEKs and POKEs, and two

bits that can be used if you want to go to more trouble.

One manufacturer, Nestar Systems, uses the IEEE port as a parallel I/O channel to interconnect several PETs to share a floppy disk drive. A ROM attached to the memory expansion contains custom software that handles Nestar's communication protocol and the extensions to the PET BASIC used for disk commands.

The PET can be used as a 21-bit I/O port—eight data lines from the user port, eight data lines from the IEEE port and five other lines for control (four from the IEEE and the CA1/CB2 handshake combination from the user port).

I was once asked to provide some serial I/O from the PET to a printer unit for testing. The interconnections were set up for the IEEE port, so I built the routines to use the IEEE bits for serial output.

Listing 3 is a BASIC program that loads the machine code shown in Listing 4 and uses it to transmit characters in serial form from the DIO lines of the IEEE 488 port. The combination permits the PET to send bytes of seven-bit ASCII in serial form using the DIO lines of the IEEE port for output.

Listing 3 loads the machine language in the data statements and then loads the baud rates array BD and the delays array RT. The user is asked for the parity to use and the baud rate, and the selected values are poked into the machine-language program. The user is then asked for the character to be sent and the number of times it is to be sent. (This program was made for test purposes and must be modified to send meaningful text.) The machine-language resident in the second cassette buffer is called to send the character.

I hand-assembled the machine-language program, Listing 4, and failed to clean it up; however, it does work! When you press the SHIFT key, the machine language will check it and return to BASIC after sending the current character. The NRFD line is used for "Printer Ready" and is checked after sending each character.

The comments are sufficient to understand the code. The transmission table is filled with 00 or FF by rotating each character through the carry bit. If this code were intended for sending different characters (instead of repeating one character many times), the table building and transmitting part of the code could be combined.

Converting the TTI levels to RS-232 is simple. Use an operational amplifier connected to ±12 volts as a comparator for output and to +5 and GND for input (see "Make PET Hard Copy Easy," by James Downey, September 1979 issue, p. 100).

IEEE 488 to Printer Interface

Since the PET treats the IEEE 488 bus as a file, the BASIC PRINT# statement may be used to send data in ASCII form. It is natural to attach a printer to the PET's IEEE bus.

Many printer manufacturers are providing the IEEE 488 interface with their printers; for example, the Comprint printer by Computer Printers International, 340 E. Middlefield Rd., Mountain View, CA 94043 ($660). I chose this one for my PET. Nearly every printer manufacturer provides the RS-232 interface, which changes the problem to providing an IEEE 488 to an RS-232 interface.

Some PET widget manufacturers provide IEEE 488 to RS-232 interfaces, for example Connecticut Microcomputer, 150 Pocono Road, Bookfield, CT 06804, and TNW Corporation, 5924 Quiet Slope Drive, San Diego, CA 92120.

If you prefer to "brew your own," Fig. 1 shows a circuit designed by Christopher L. McAfee that provides a one address listener on the IEEE bus to RS-232 interface. Another approach is described in "Make

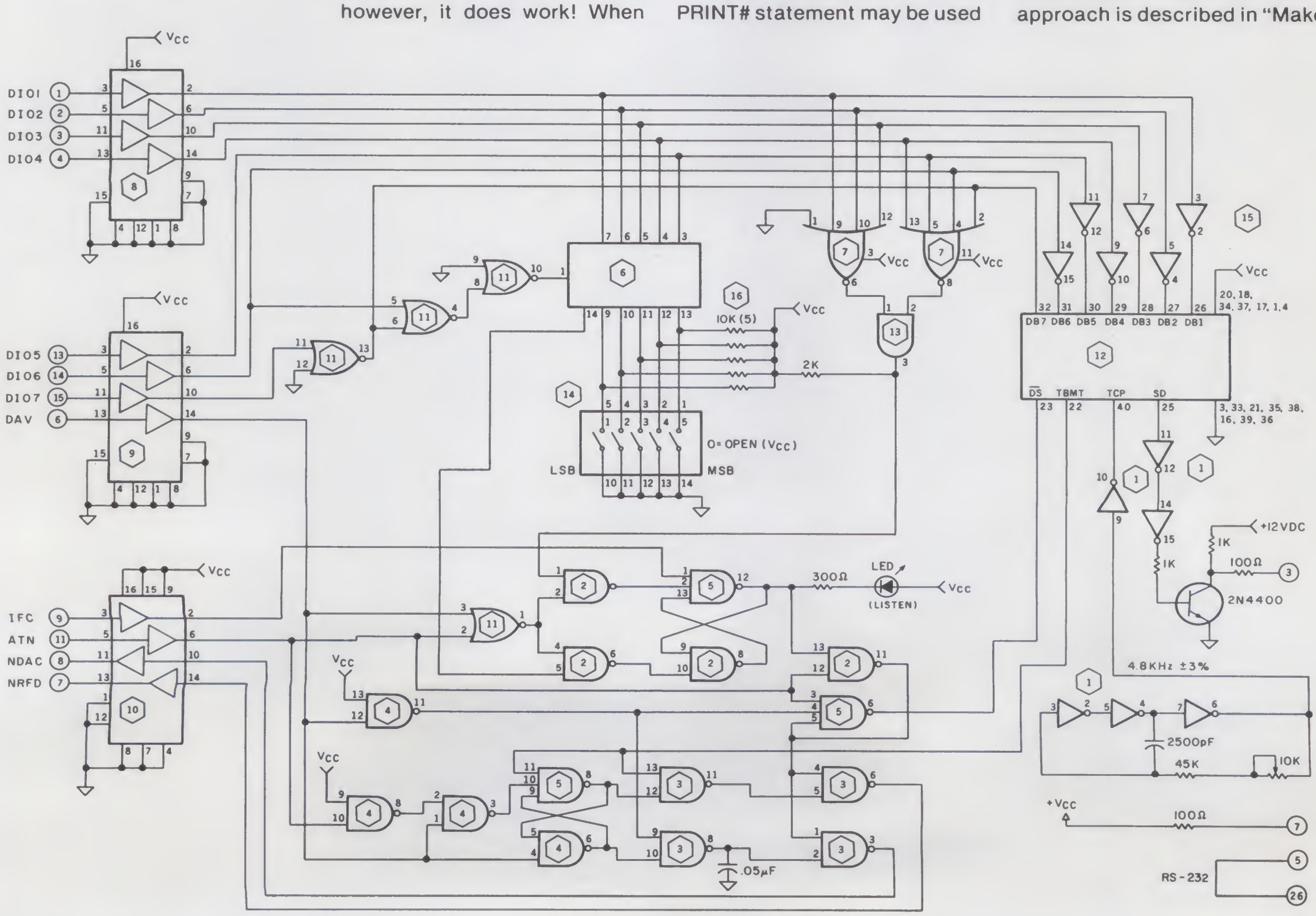

Fig. 1. IEEE 488 to RS-232 printer interface.

PET Hard Copy Easy," *Kilobaud Microcomputing*, September 1979, p. 100.

Printing Hazards

The difference between the PET's display and character codes and the ASCII character set causes some difficulties when you use the IEEE 488 bus for printed output.

1. ASCII printers use the most significant bit (MSB) as a parity bit. If the PET is sending a graphics character (or lowercase, as provided by the POKE 59468,14 for old PETs), the printer will either ignore this and print the corresponding ASCII for the seven less significant bits or print a "parity error" character. If you get a parity error character, set your printer to the "no parity," or "mark" parity, option.

2. The PET cursor control characters result in the ASCII values in the range 0 to 31, which are control characters in ASCII. If you are lucky, these will be ignored; if you aren't, some of these may result in setting your printer to unwanted modes. (The Comprint printer is a "lucky" one.)

3. As a result of these first two steps, if you use CMD and LIST, the listings you get will have missing or misleading characters. I have a program (drop me a card) that will list a BASIC program in a legible form.

4. The PET does not transmit a line feed. You must provide CHR$(10) after every carriage return.

5. If your printer needs a carriage return delay, either print the required number of CHR$(0) or insert a small waiting loop; i.e., FORJ = 1TO20:NEXT.

6. Most printers have no formatting capabilities. If you keep careful count of the number of characters sent, formatting is clumsy, but possible. Pitfalls include:

•A printed number has a CHR$(29) sent after the last digit, which is not a space and is usually ignored by printers.

•TAB and SPC provide CHR$(29), and not spaces. (New PETs have this fixed.)

•LEN(STR$(number)) will not count a CHR$(29), since STR$ produces a string without a blank or skip after the last digit.

•If the number is small or large, beware of scientific format; i.e., 1.23E + 23.

7. If you are attempting a word-processing program, the PET's codes for the lowercase characters and the ASCII codes are different. The PET thinks the lowercase letters lie in the range 192 to 223, and ASCII likes the range 96 to 127.

A further complication is that the ASCII character set and the PET character sets don't match. Backarrow on the PET is ASCII underline; the curly brackets, vertical bar and tilde in ASCII don't exist on the PET. The ASCII accent mark (looks like a reverse apostrophe) is seen by the PET as a space. Your printer might have other character options to puzzle you.

Wrapping It Up

Working with the IEEE 488 bus is nearly an entire engineering discipline in itself. I hope my efforts enable you to get aboard the IEEE 488 bus of your PET and turn it to some profitable use. ■

References

1. "IEEE Standard Digital Interface for Programmable Instrumentation," IEEE Std 488-1975, ANSI MC 1.1-1975.

2. Hewlett-Packard, 1502 Page Mill Road, Palo Alto, CA or PO Box 301, Loveland, CO 80537. Several publications are available on request.

3. "PET 2001-8 User's Manual" and "PET Communication with the Outside World," Commodore Business Machines.

4. "Getting Aboard the 488-1975 Bus," Motorola.

5. "PET User Notes," PO Box 371, Montgomeryville, PA 18936.

6. MOS Technology, Inc., 950 Rittenhouse Road, Norristown, PA 19401.

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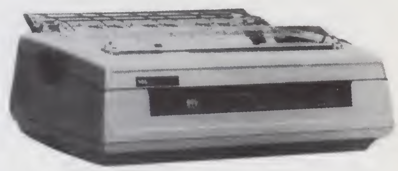

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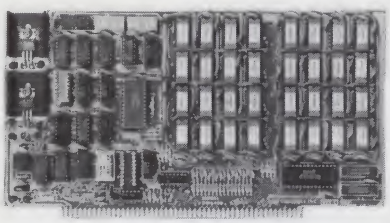

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✓ Reader Service index—page 241

PET I/O Port Expander

This series concludes on a musical note.

William F. Pytlik
9012 Maritime Ct.
Springfield VA 22153

Many games available for the PET now include sound-effect/music capability. Unfortunately, the PET does not have provisions to play music directly. Implementing this capability is simple, especially if you use the I/O Port "Expander" as a basis (see part 1 of this series, June 1980, p. 58).

All programs use the CB2 port to serially shift out 1s and 0s to produce different frequencies. The circuit uses a simple audio amplifier IC1. Fig. 1 shows a schematic of this sound module. Volume is controlled by R4, which should be part of the basic Expander. The entire circuit uses a 3 x 4 inch printed circuit (PC) board. All components are wired as shown in Fig. 1.

Fig. 2 presents a full-size PC pattern of this module. A heat sink is glued to IC1 to prevent heat damage. The speaker in the basic Expander may be wired to a jack on the back of the chassis, allowing an external speaker to be used. Photo 1 shows the completed audio module.

Photo 1. Completed audio module.

Making Music

To use CB2 to produce a continuous note, you must access the following memory locations:

POKE 59467, 16	Prepares CB2 for use
POKE 59466, 15	Establishes a symmetrical square wave
POKE 59464, NTE	Plays note of frequency (1000000/(NTE + 2)* 16)

When these versatile interface adapter (VIA) functions are used, loss of tape operation results. Consequently, save any music/sound programs prior to running them. Normal operation is restored by:

```
POKE 59467, 0
POKE 59466, 0
POKE 59464, 0
POKE 59468, 12
```

To produce sound effects, simply experiment with the above POKE commands. To transcribe or compose music, I've used a simple structure to save music data: all notes are saved as DATA statements beginning with the line

```
500 DATA NUM, DUR, CODE
```

NUM is the number corresponding to a particular note (see Fig. 3); DUR is the duration in sixteenths; and CODE is a code to specify a flat, sharp, end of music or replay. The following frequencies are associated with the notes in Fig. 3.

Note	N	Frequency (F)-Hz
C	1	523.2
D	2	587.3
E	3	659.2
F	4	698.4
G	5	783.9
A	6	880
B	7	987.7
C	8	1046.5
D	9	1174
E	10	1318.5
F	11	1396.9
G	12	1567.9
A	13	1760

With this information, you can write a program to store any musical composition. Listing 1 shows a self-documenting music routine that plays a simple waltz.

Whether you use the audio module for random notes, sound effects or serious composition, it is certain to provide hours of

R1—220k 1/4 Watt resistor
R2—47k 1/4 Watt resistor
R3—75k 1/4 Watt resistor
R4—50k audio taper potentiometer
C1—.1 μF capacitor
C2—470 μF capacitor
IC1—LM380 audio amplifier
S1—SPST (device select) switch
Misc.—Wire, hardware, IC sockets, speaker

Table 1. Parts list.

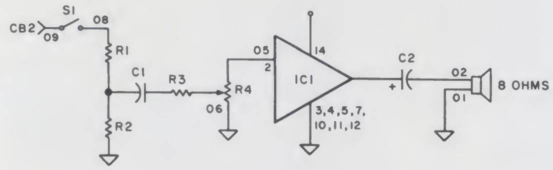

Fig. 1. Sound module circuit.

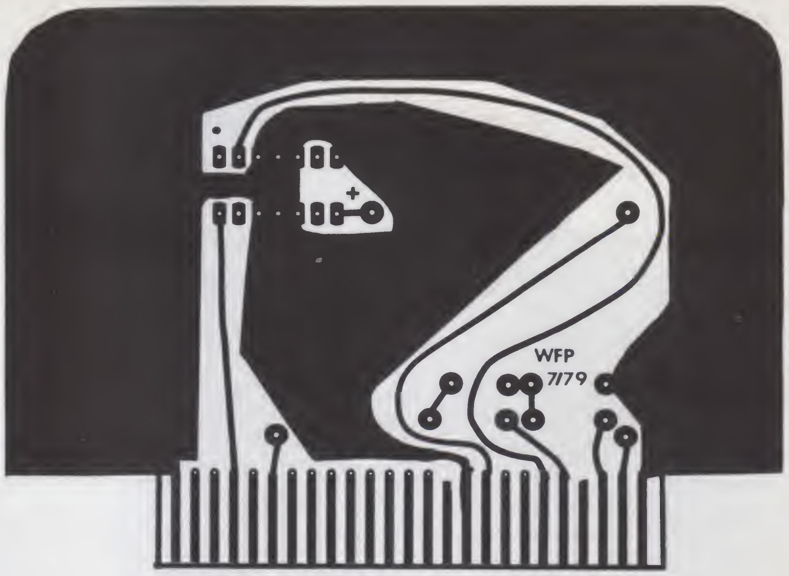

Fig. 2. Printed circuit board (full size).

enjoyment. My wife, a Girl Scout leader, often needs music during singing sessions with the girls. Since she does not play a musical instrument, all she has to do is enter the music data into the computer, which will play in the notes in the proper tempo, ready for recording. It's not a symphony orchestra, but it does provide adequate quality to lead a singing session. ■

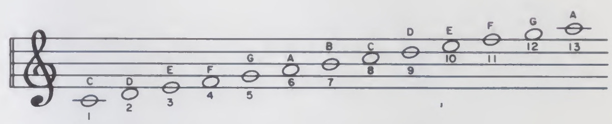

Fig. 3. Number/note assignments.

Listing 1.

```
 10 DIM F(15)
 20 GOSUB 2000
 30 PRINT"□ *** MUSIC ROUTINE ***"
 40 REM  **READIES CB2 FOR USE**
 50 POKE 59467,16:POKE 59466,15
 60 REM  **LENGTH OF NOTES IN SECONDS**
 70 TEMPO=.9
 80 REM  **READ NUMBER,DURATION, AND COD
E OF NOTE**
 90 READ NUM,DUR,CODE
 100 REM  **DETERMINE VALUE FOR NOTE**
 110 GOSUB 1000
 120 REM  **START TIME OF NOTE**
 130 CC=TI
 140 REM  **PLAY QUICK PAUSE AND THEN NO
TE**
 150 POKE 59464,0:POKE 59464,NTE
 160 REM  **CHECK FOR DURATION OF NOTE**
 170 X=TI:IF((X-CC)/60)<TEMPO*(DUR/16) T
HEN 170
 180 REM  **PLAY AGAIN**
 190 IF CODE=3 THEN RESTORE:GOTO 90
 200 IF CODE=4 THEN 10000
 210 GOTO 90
 250 END
 510 DATA 2,4,0,3,8,0,5,4,0,3,8,0,5,4,0,
4,2,1,5,2,0
 520 DATA 6,8,0,6,8,0,2,4,0,3,8,0,4,4,1,
2,8,0
 530 DATA 8,4,0,7,2,0,8,2,0,9,8,0,9,8,0,
10,4,0
 540 DATA 9,8,0,8,4,0,7,8,0,9,4,0,8,4,0,
8,2,0,7,2,0
 550 DATA 6,4,0,7,4,0,8,8,0,8,4,0,7,8,0,
6,4,0
 560 DATA 5,8,0,7,4,0,6,4,0,6,2,0,5,2,0,
4,2,1
 570 DATA 5,2,1,6,8,0,2,4,0,3,8,0,5,4,0,
3,8,0
 580 DATA 5,4,0,4,2,1,5,2,1,6,8,0,6,8,0,
2,4,0
 590 DATA 3,8,0,4,4,1,6,8,0,8,4,0,7,2,0,
8,2,0
 600 DATA 9,8,0,9,8,0,9,4,0,10,8,0,9,4,0
,8,8,0
 610 DATA 10,4,0,9,4,0,9,2,0,8,2,0,7,2,0
,8,2,0,9,8,0
 620 DATA 2,4,0,3,8,0,5,4,0,3,8,0,9,4,0,
7,2,0,6,2,0,5,8,0,5,12,3
 1000 REM  ***DETERMINE VALUE TO BE POKE
'D INTO 59464***
 1005 F=F(NUM)
 1010 IF C=1 THEN F=F(NUM)+(F(NUM+1)-F(N
UM)/2)
 1020 IF C=2 THEN F=F(NUM)-(F(NUM)-F(NUM
-1)/2)
 1030 NTE=INT((((1000000/F)/16)-2)+.5)
 1040 RETURN
 2000 REM  ***FREQUENCIES***
 2010 F(1)=523.2:F(2)=587.3:F(3)=659.2
 2020 F(4)=698.4:F(5)=783.9:F(6)=880
 2030 F(7)=987.7:F(8)=1046.5:F(9)=1174
 2040 F(10)=1318.5:F(11)=1396.9:F(12)=15
67.9
 2050 F(13)=1760
 2060 RETURN
 10000 POKE 59466,0:POKE 59467,0:POKE 59
464,0:POKE 59468,12
```

The PET/CMC/H14 Connection

Heath's low-cost printer finds yet another home.

Neil J. Omvedt
8224 Kensington Square
Jacksonville, FL 32217

If you are looking for a printer to go with your Commodore PET computer, you might be interested in the Heath H14.

The H14 is RS-232C compatible, has a tractor feed and uses the 96-character ASCII set. It prints on 9½ inch paper at 80, 96 or 132 characters per line. It outputs up to 165 characters per second, one full line every two seconds.

The price is right, too. I paid $595 for the kit. Including the cost of the adapter (Connecticut Microcomputer Corp.'s ADA 1200), my bill came to $764, much less than the advertised price of $995 for Commodore's tractor-feed printer.

One of the H14's drawbacks is that it does not offer graphics (this did not bother me, since I had bought my PET mostly for computational purposes). On the other hand, the printer can be interfaced with other microcomputers.

When the kit arrived (it took six weeks), I immediately examined the instructions. I had to tape a number of correction pages over the originals.

Heath also included a set of modifications to be used if the computer requires the *complement* of the busy signal on line 4 of the connection. I put these aside and did not use them.

Problems

I had a few problems constructing the kit. A couple of screws and one clamp were missing or defective. Some of the connections to the switches were difficult to reach for soldering. I had trouble installing the two LEDs on the front panel. Also, the thumbscrew on the right paper-feed sprocket did not turn easily. Construction took about 30 hours.

In running through the initial tests, I discovered that several of the instructions were incorrect. Heath has since issued a correction.

Once the printer was up and running, I noted several other problems. First, the printhead did not print the top row of dots properly. I corrected this with some readjustment. Second, fuses were blowing. I'm still not sure of the cause—it may have been because of improper use or settings. I haven't had any trouble lately.

Third, the ADA 1200 adapter doesn't recognize the Commodore tab settings. To print formatted columns of output, I need to use the Commodore's internal string functions.

Before using the printer, I had to make several settings on the printer adapter and printer. Each has a set of slide switches. On the CMC PET ADA 1200, I set the five slide switches as in Table 1. On the Heath H14 printer, I set them as in Table 2.

After using the printer for some time I desired a higher speed so I took the adapter to a local Computerland shop and had them set it to 600 baud. In this process we discovered that the adapter does not have a line for a return signal from the printer to indicate that the buffers are full. Thus, when the printer is run at 600 baud it tends to overload and the printer will stop printing.

One method of solving this is to use a machine-language program supplied by CMC which interrupts the output sufficiently to keep the printer from overloading. I have since discovered however that this machine-language program does not work properly with the new BASIC ROMs.

The other method is to add an additional line from the printer to the adapter to carry the return code. My understanding is that this also requires modification of the output from the H14 printer, but I have been unable to obtain the exact information to do this myself.

For those not interested *in putting kits* together, the Heath H14 comes assembled, for $895 from Heath and at lower prices from other suppliers. Also, other RS-232 adapters for the PET are now available. Some of them provide an additional output port for the IEEE bus of the PET so that other devices may be added.■

Switch	Setting	Reason
1	off	No parity bits on H14
2	on	One stop bit used by H14
3 and 4	off	Eight bits per character used by H14
5	off	No parity bits

Table 1. ADA 1200 slide switch settings.

Switch	Setting	Reason
0	1	Noncontinuous test mode
1	1	Assembly manual instructions
2	1	Power line frequency of 60 Hz
3	1	Assembly manual instructions
4	1	Assembly manual instructions
5	1	300 baud rate of PET ADA 1200
6	0	300 baud rate of PET ADA 1200
7	1	300 baud rate of PET ADA 1200

Table 2. H14 slide switch settings.

Word Processing HMCT Style
MAGIC WAND
Reference Card
MAGIC WAND
3M
NEC
OVER RIDE
ALARM
PAPER
READY
FF
CLEAR
POWER
Using the best in word processing software **the Magic Wand™**, the best in letter quality printers **the NEC Spinwriter™**, and the well-known **TRS-80™ MOD II.** You have looked and looked for the best and now it is available from the **Complete Computer Company, HMCT.** Word Processing at its best from $7500.
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Perhaps you'd like to buy a microcomputer, but don't want to spend a lot of money. Or maybe you need only limited computer capabilities for use in a simple controller, toy, game or remote controller.

In either case, the microcomputer you need should be easy to use and expandable. The 8085A-based microcomputer could be what you're looking for.

The 8085A (see Photos 1 and 2) is a good low-cost trainer. With the keyboard/display board, you can use either the hexadecimal or octal numbering systems and store the programs in read/write memory. You can then use the debugger portion of the system monitor to execute programs and observe the results.

If you are already experienced, the 8085A is ideal for many tasks. You can use it, for example, as a programmable telephone dialer. The 8085A CPU chip has a one-bit output port to drive a reed relay, which simulates the rotary dial in the telephone. The 8085A will even operate as a digital clock when not dialing or timing long-distance calls.

As an EPROM programmer, the 8085A receives data from a host computer via the CPU chip's one-bit input port or from the keyboard/display board. The microcomputer then programs the selected EPROM memory location and verifies that the location has been programmed properly.

The 8085A can also be used as a darkroom enlarger controller, a model railroad controller, a data logger or a print controller.

Microcomputer Hardware

The CPU card contains the 8085A CPU chip, the memory, buffer, and memory and input/output (I/O) decoder circuitry. The keyboard/display board, along with a 24-key keyboard and a nine-digit LED display, has input and output ports to control them. By separating the CPU functions from the keyboard/display functions, you can plug the CPU card into an instrument for use as a dedicated controller or for program development, without using the keyboard/display.

Only ten integrated circuits are required on both the CPU board and the keyboard/display board. The simplest system, based on the CPU card alone, consists of the 8085A, 1K to 8K of read-only memory and 1K of R/W memory, based on the popular 2114 chip.

The CPU card also has a 20 mA asynchronous serial port, based on the 8085A's one-bit input and output ports. This serial port can be used with teletypewriters and CRTs.

If you don't have a teletypewriter or CRT that is compatible with the CPU card, the keyboard/display board can be used. Both the keyboard and displays are controlled with assembly-language software, so you need very few electrical connections. To eliminate the costs of edge connectors and a motherboard, a 16-conductor DIP cable connects the two boards.

You can use the keyboard/display board to program the 8085A in machine and assembly language. The system monitor program, which is contained in IC4,

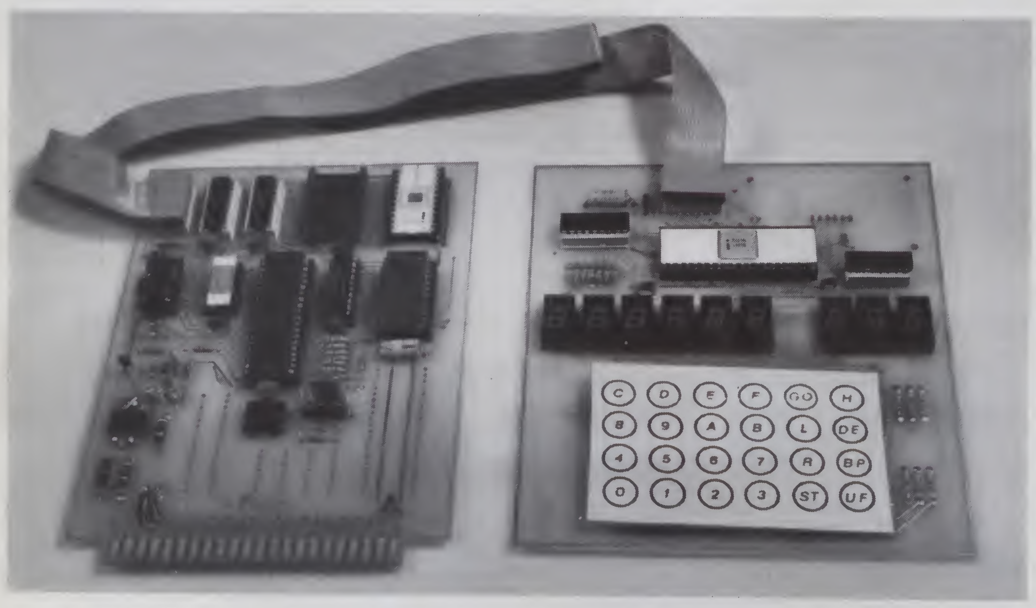

Photo 1. The complete system.

Semiconductors

IC1	8085A microprocessor
IC2	SN74LS245 eight-bit, bidirectional buffer
IC3	8212 eight-bit input/output port
IC4	2708 system monitor EPROM
IC5	Optional 2708 EPROM
IC6, IC7	2114 1K × 4 450 ns static R/W memory
IC8	93427PC 256 × 4 PROM or equivalent
IC9	LM320T-5.0 −5 V voltage regulator (TO-220)
IC12	8255A programmable peripheral interface (PPI)
IC13	UDN2981A high-voltage, high-current source driver
IC14	SN74145 BCD-to-decimal decoder/driver
IC15-IC23	MAN74 (Monsanto), DL-704 (Litronix) or equivalent seven-segment LED display
Q1, Q2	2N2907A pnp transistors

Components

C1	3.3 uF, 50 V axial electrolytic
C2	2.2 uF, 35 V tantalum
C3, C5	1 uF, 35 V tantalum
C4, C7-C13, C16 C18, C19	0.01 uF, 50 V ceramic disk
C6	22 uF, 16 V axial electrolytic
C14, C15	22 pF, 50 V ceramic disk
C17	33 uF, 10 V axial electrolytic
R1	56k ohm, ¼ W, 10 percent resistor
R2-R8, R13, R27-R32	1k ohm, ¼ W, 10 percent resistor
R9-R11	10k ohm, ¼ W, 10 percent resistor
R12	2.7k ohm, ¼ W, 10 percent resistor
R14, R15	470 ohm, ½ W, 10 percent resistor
R16	1.6k ohm, ¼ W, 10 percent resistor
R17	560 ohm, ½ W, 10 percent resistor
R18	220 ohm, ¼ W, 10 percent resistor
R19	4.7k ohm, ¼ W, 10 percent resistor
R20-R26	39 ohm, ¼ W, 10 percent resistor
D1	1N4148 signal diode
XTAL1	6.144 MHz quartz crystal (parallel resonance)
PB1	Panasonic EVO-P1R (or equivalent) push button
KYB1	Texas Instruments 11 KS120 24-key keyboard

Sockets

2	40-pin low profile solder tail sockets
3	24-pin low profile solder tail sockets
1	20-pin low profile solder tail sockets
3	18-pin low profile solder tail sockets
5	16-pin low profile solder tail sockets
9	14-pin low profile solder tail sockets

Miscellaneous

CPU and keyboard/display printed circuit boards, 24 inch DIP cable (AP 924116-24 or equivalent), 16-pin DIP header, keyboard legend and wire for jumpers.

Parts list.

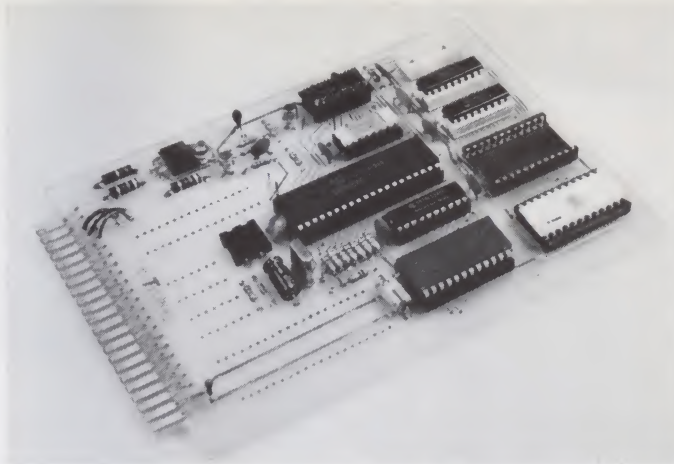

Photo 2. The CPU card.

a 2708 EPROM (1K × 8), lets you use either hexadecimal or octal numbers, examine and modify the content of memory, execute a program stored in memory, set and remove a breakpoint and execute one instruction at a time (single-step). You can also examine and modify the content of the general-purpose registers contained within the 8085A CPU chip.

The CPU circuitry (Fig. 1) is on a standard 4.5 × 6.5 inch card with a 44-pin edge connector, and can be easily placed in a rack system for memory and peripheral expansion.

Also, for custom memory and interface designs, you can use standard wire-wrap cards. You determine the bus system used by the microcomputer, since the edge connector fingers are largely uncommitted to particular signals. Therefore, the CPU card can be used with other boards designed for 6800-, 6502-, 1802- and Z-80-based microcomputers.

The CPU card also contains a small wire-wrap area so that additional buffers, gates or decoders can be added to the CPU card. This card has enough space for one 40-pin DIP, two 16-pin DIPs and one 20-pin DIP. You could use this wire-wrap area for RS-232C-to-TTL and TTL-to-RS-232C conversion circuitry, or for use with asynchronous RS-232C-compatible terminals or printers.

The CPU card has another exciting feature: As denser EPROMs become less expensive, they can be plugged into EPROM sockets originally designed for use with 2708 EPROMs. The CPU card has two sockets; thus, the system can have up to 2048 words of read-only memory (2708).

To use 2716-type EPROMs (either one- or three-supply devices), add a jumper to the CPU card and reconfigure a 16-pin DIP header with a few wires. You can use even denser EPROMs, but you would have to use a different decoder integrated circuit and rewire the DIP header.

The three chips used in the keyboard/display board are an 8255A programmable peripheral interface (PPI) chip, a digit-driver chip (SN74145) and a segment-driver chip (Sprague UDN 2981A). The 16-conductor cable interconnecting the two cards provides power for the chips, as well as the data, address and control signals required by the PPI chip. Therefore, small custom interfaces can be designed with a single PPI chip and wired to the CPU card with this same 16-conductor cable.

How the Microcomputer Works

When the microprocessor is turned on the quartz crystal starts to oscillate at 6.144 MHz, and the reset circuitry, consisting of R1 and C1, resets the microprocessor. Once the reset capacitor (C1) is charged to 2.4 V or greater, the microprocessor is no longer reset, so it has to read the first instruction from memory location zero and execute it.

The 8085A can address 65,536 eight-bit memory locations, so it generates a 16-bit memory address whenever it reads or writes information to or from memory. The 8085A also generates memory control signals, so that the memory integrated circuits only gate data off of, or gate data on to, the data bus at the appropriate times.

The memory control signals are called read ($\overline{RD}$), write ($\overline{WR}$) and input-output/memory (IO/$\overline{M}$). (The bar over the signal name indicates that their unique state is a logic zero: 0.4 V or less.) When the 8085A reads from memory, the $\overline{RD}$ and IO/$\overline{M}$ signals will be logic zeros, and $\overline{WR}$ will be a logic one. To write information into memory, $\overline{WR}$ and IO/$\overline{M}$ will be logic zeros and $\overline{RD}$ will be a logic one.

The 8080A, the predecessor of the 8085A, uses 16 of its 40 pins to output a 16-bit address and eight of the 40 pins for a bidirectional data bus. To incorporate a number of improvements into the 8085A CPU chip, the eight least-significant ad-

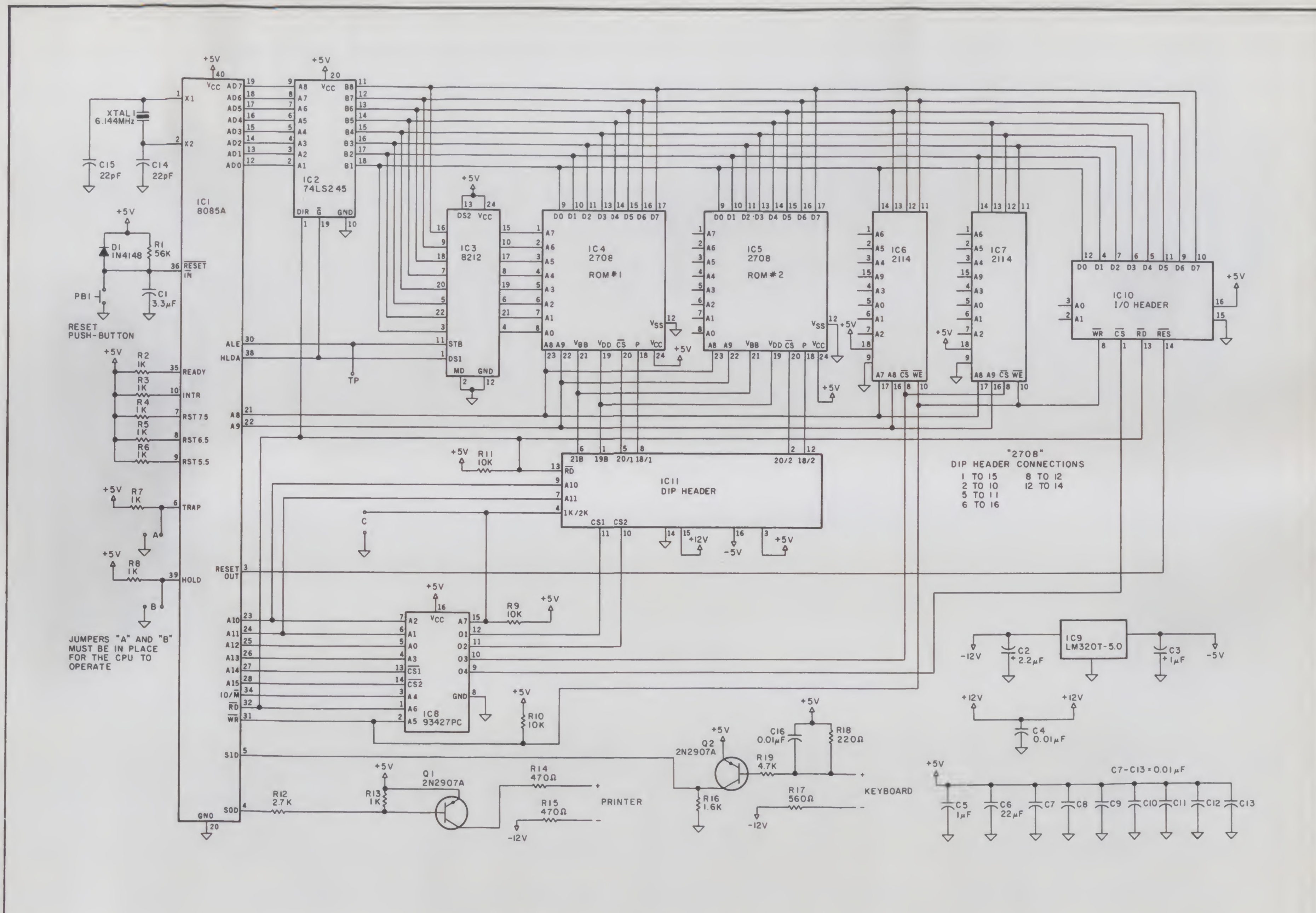

Fig. 1. 8085A CPU card schematic diagram.

8085A outputs	A15	A14	+5 V	$\overline{RD}$	$\overline{WR}$	IO/$\overline{M}$	A13	A10	A11	A12				
93427PC inputs	$\overline{CS2}$	$\overline{CS1}$	A7	A6	A5	A4	A3	A2	A1	A0				
93427PC outputs											01	02	03	04
2708 #1 selected	0	0	1	0	1	0	0	0	0	0	0	1	1	1
2708 #2 selected	0	0	1	0	1	0	0	1	0	0	1	0	1	1
R/W mem. selected	0	0	1	0	1	0	1	1	1	1	1	1	0	1
R/W mem. selected	0	0	1	1	0	0	1	1	1	1	1	1	0	1
8255A selected*	0	0	1	0	1	1	0	0	0	0	1	1	1	0
8255A selected*	0	0	1	1	0	1	0	0	0	0	1	1	1	0

* The 8255A PPI chip is contained on the keyboard/display board

Table 1. Truth table for the Fairchild 93427PC (or equivalent) 256 × 4 PROM.

dress signals (A0–A7) are multiplexed with the eight data signals. The resulting pins on the 8085A are called AD0–AD7 (address-data zero through address-data seven).

So that external devices know when an address is present on these eight pins, the 8085A also generates an address latch enable (ALE) signal. When this signal is a logic one, the 8085A is placing an address on pins AD0 through AD7. At the same time, the eight most-significant address bits, A8–A15, are on their pins. When ALE is a logic zero, the address-data bus pins may or may not contain data. If these pins do contain data, its direction of flow is determined by the $\overline{RD}$, $\overline{WR}$ and IO/$\overline{M}$ signals.

Therefore, whenever the 8085A executes a program, an address is present on AD0–AD7 and on A8–A15. At the same time, the ALE signal is a logic one. Since the address on AD0–AD7 is only valid when the ALE signal is a logic one (a maximum of 143 ns if a 6.144 MHz quartz crystal is used with the 8085A), the address must be latched off of these pins by external circuitry.

In general, an address must be present for at least 300–450 ns on the address inputs of memory integrated circuits before information can be written into, or read from, the specified memory location. Therefore, this external circuitry has to latch the address, when ALE is a logic one. The address being output by the latch should only change when the ALE signal is a logic one. By using a latch, the memory and peripheral circuits have enough time to recognize their address and perform the appropriate data-read or data-write operation. The latch used in this design is an 8212 (IC3, Fig. 1).

Once part of the address is latched, additional external logic must decode the 16-bit address generated by the 8085A. In the design shown in Fig. 1 this address must cause IC4, IC5 or both IC6 and IC7 to be selected. Since IC6 and IC7 are 1024 word × four-bit R/W memories, you need two of these chips to form 1024 words of eight-bit R/W memory. Since the 8085A is an eight-bit microprocessor, it normally accesses memory locations that are eight bits wide. The EPROMs (IC4 and IC5) contain either 1024, 2048 or 4096 eight-bit words, so only one of them—regardless of the type or size of memory used—can be selected at a time. Since the memories contain at least 1024 words, internal logic in the memory chips causes only one word to be selected. We do not have to be concerned with this internal memory logic.

In most 8085A microcomputer designs, the microcomputer executes instructions stored in read-only memory when the CPU chip is reset. Therefore, in this design, the 8085A should select and execute the instructions stored in either IC4 or IC5. Since these are EPROMs, the external decoder logic should be designed so that the 8085A is only able to read information from the EPROMs.

Whenever a read-only memory is selected, it places data on the data bus. This may cause problems if the 8085A ever tries to write information to a read-only memory, because both devices will be placing information on the data bus at the same time.

Of course, the 8085A can write information into or read information from read/write (R/W) memories. Therefore, the external memory address decoding logic must only cause a particular eight-bit memory location to be selected when the 8085A generates the appropriate 16-bit memory address and is performing the proper operation. IC8, a programmable read-only memory (PROM) with 256 four-bit words, does this.

The PROM, used as a programmable decoder, has been programmed according to Table 1. EPROMs are only selected when memory-read operations take place and the appropriate address is contained on the address bus. Also, read/write memory is selected when either a memory-read or memory-write operation is taking place and the appropriate address is on the address bus. Likewise, since information must be written to and read from the keyboard/display board, the 8255A PPI chip contained in it must be selected during either an I/O-read or I/O-write operation.

From Table 1, you can determine the addresses of the memory and I/O chips. These addresses are summarized in Table 2.

If you use a PROM as a decoder, newer and more dense memories can be plugged into the sockets for IC4 and IC5, and a new PROM can be programmed to generate the chip select signals at the appropriate times. As an example, suppose that you use 2716 (2K × 8) EPROMs. The first 2716 (IC4) must be selected when the 8085A reads from memory locations 0000000000000000 through 0000011111111111, and the second 2716 (IC5) must be selected when the 8085A reads from memory locations 0000100000000000 through 0000111111111111. In fact, the 93427PC PROM (or equivalent) available with the kit of parts is made for either two 2708 (1K × 8) or two 2716 (2K × 8) EPROMs.

To use the microcomputer with 2716 EPROMs, you must add the C jumper to the PC board, so that the A7 input of the 93427PC (or equivalent) is grounded. Also, *you must rewire* the DIP header, according to the type of 2716 being used (single or triple supply). The wire lists for the different configurations of the DIP header are shown in Table 3.

	Binary	Hex	Octal
2708 #1	0000000000000000 through 0000001111111111	0000 through 0377	000 000 through 003 377
2708 #2	0000010000000000 through 0000011111111111	0400 through 07FF	004 000 through 007 377
R/W memory	0011110000000000 through 0011111111111111	3C00 through 3FFF	074 000 through 077 377
8255A PPI*	00000000 through 00000011	00 through 03	000 through 003

* Accumulator I/O has been used for the PPI chip, so only an eight-bit address is required to uniquely address a device.

Table 2. Addresses for memory and peripheral devices.

As instructions are fetched from EPROM (IC4 and/or IC5) and are executed, the microprocessor stores and retrieves values from R/W memory. Therefore, both R/W memory chips (IC6 and IC7) must be in place in the CPU card, and they both must be operating properly.

Once the program in EPROM is executed, alphanumeric information is displayed on the keyboard/display board, and you can use the keyboard to enter numeric values or commands. Since R/W memory is used by the system monitor program for a stack and for temporary data storage, you should not try to store any information in R/W memory above memory address 3FC0 (077 300).

Keyboard/Display Operation

Even though the keyboard/display board contains the complex PPI peripheral chip, you can think of it as two eight-bit output ports and one eight-bit input port. The A output port (I/O address 00000000) drives individual segments within the seven-segment displays. I've used individual segment drivers (IC13, Sprague UDN2981A) so that any combination of segments within an individual display can be turned on.

The value output on the four least-significant bits of port C (I/O address 00000010) are decoded by IC14 (SN74145), and the logic zero output of this decoder determines which digit will be enabled or will display information. Therefore, the UDN2981A provides the segment current, and the SN74145 determines through which digit this current will flow. By writing different values out to the segment driver and decoder quickly enough (new data every 10 or 20 ms), a number of digits in the display will appear to be turned on all of the time.

The four most-significant bits of port C and the six least-significant bits of port B (I/O address 00000001) interface the keyboard to the microcomputer (see Fig. 2). To determine if a key is pressed, the 8085A microprocessor writes different patterns of logic ones and logic zeros out to the four most-significant bits of port C.

For example, if 1110 is output, the logic zero is present on the PC4 pin of the 8255A. This logic zero provides a path to ground for current from any of the six 1k pullup resistors (R27–R32) wired to the keyboard. If the zero key is pressed, the logic zero on the PC4 output sinks the current from R27 that is wired to the PB5 input of the PPI chip. Since port B is an input port, the 8085A senses this logic zero with soft-

Wire	Purpose
2708 (1K × 8)	
1 to 15	+ 12 to pin 19 of both 2708s
2 to 10	$\overline{CS}$ signal to 2708 #2 (IC5)
5 to 11	$\overline{CS}$ signal to 2708 #1 (IC4)
6 to 16	− 5 to pin 21 of both 2708s
8 to 12 to 14	GND to pin 18 of both 2708s
TMS 2716 (2K × 8, three supply)*	
1 to 15	+ 12 to pin 19 of both TMS2716s
2 to 5 to 9	A10 to pin 20 of both TMS2716s
10 to 12	$\overline{CS}$ signal to TMS2716 #2 (IC5)
11 to 8	$\overline{CS}$ signal to TMS2716 #1 (IC4)
6 to 16	− 5 to pin 21 of both TMS2716s
2716 (2K × 8, one supply)*	
9 to 1	A10 to pin 19 of both 2716s
10 to 12	$\overline{CS}$ signal to 2716 #2 (IC5)
11 to 8	$\overline{CS}$ signal to 2716 #1 (IC4)
2 to 5 to 13	$\overline{RD}$ to pin 20 of both 2716s
3 to 6	+ 5 to pin 21 of both 2716s

* To use *any* type of 2K × 8 EPROM, the C jumper must be added to the CPU card (to the left and above of pin 1 of the 93427PC or equivalent PROM).

Table 3. Configuring the DIP header for different EPROMs.

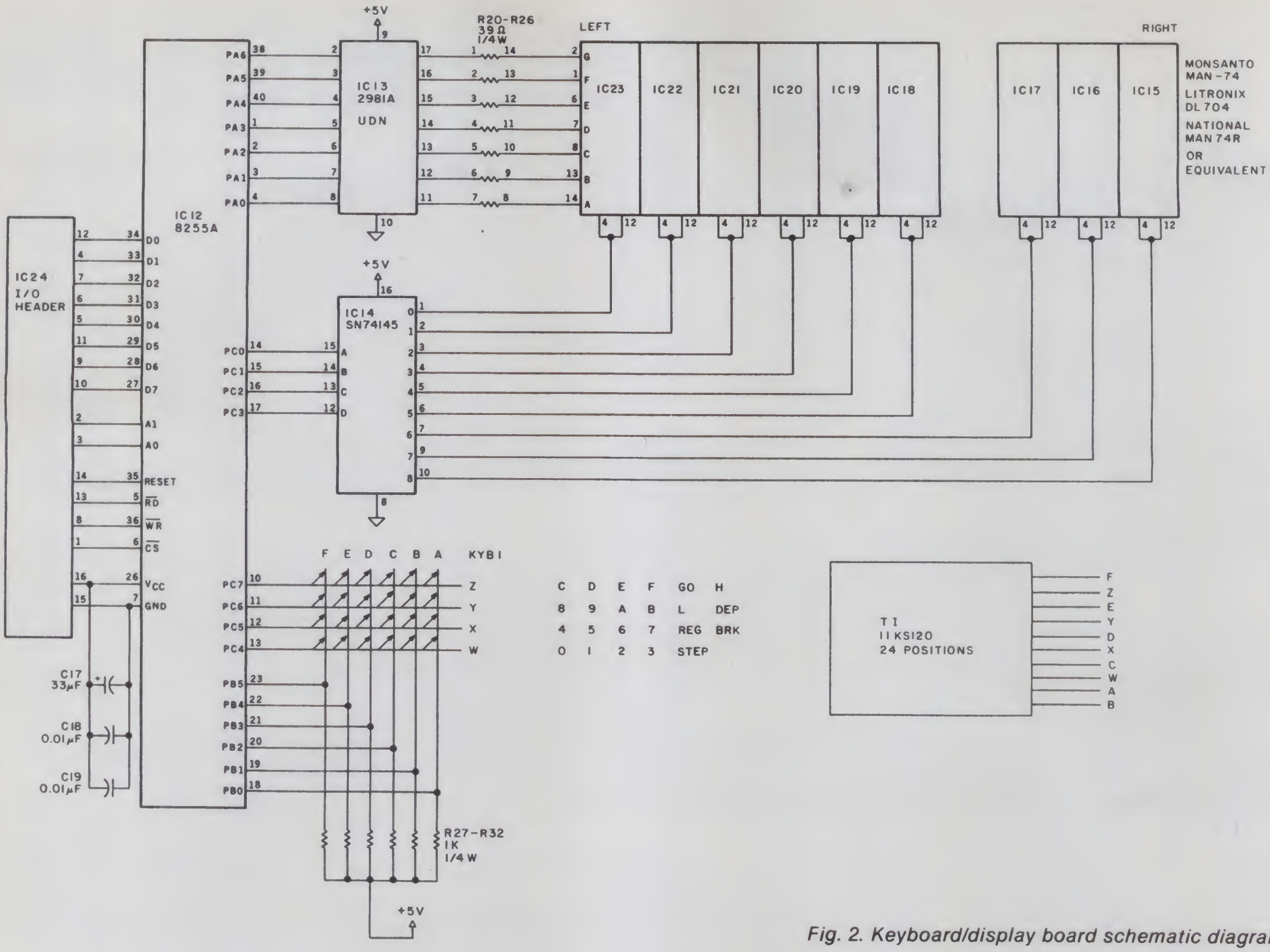

Fig. 2. Keyboard/display board schematic diagram.

ware and determines that the zero key is pressed. While the PC4 output of the PPI chip is a logic zero, the 8085A senses whether the 0, 1, 2, 3, STEP or * keys are pressed. If none are pressed, the 8085A outputs a 1101 on the four most-significant bits of output port C, so that the 4, 5, 6, 7, REG and BRK keys can be tested.

Writing out different values to the displays and sensing which, if any, key is pressed requires much assembly-language software. If you want to know how this is done, refer to chapter 7 of *8080/8085 Software Design, Book 1.*

Additional 8085A Features

The 8085A has five priority interrupt inputs (TRAP, RST7.5, RST6.5, RST5.5 and INTR), four of which are also vectored (all except INTR). If the 8085A's interrupt is enabled and the appropriate signal is applied to one of these inputs, the 8085A will start to execute an interrupt service subroutine that is specific for that input. The interrupt service subroutines are stored in memory from 0024 (000 044) through 003C (000 074).

You can use the TRAP input to interrupt the 8085A, even when the interrupt is not enabled. By using some external hardware with the INTR input, you can add eight vectored priority interrupts. With these interrupts, however, the 8085A will start to execute interrupt service subroutines that are stored in memory from 0000 (000 000) through 0038 (000 070).

Regardless of which interrupt input is used, the 8085A will start to execute interrupt service subroutines stored within the first 60_{10} memory locations. Unfortunately, in this microcomputer system, the system monitor EPROM occupies these memory locations.

However, you can use these interrupt inputs and still write your own interrupt service subroutines. Jump instructions are contained in these first 60 memory locations so that when an interrupt occurs, the 8085A jumps to memory locations 3F80 (077 200) through 3FBC (077 274). The interrupts and the memory locations to which program control is transferred are summarized in Table 4. Since the memory locations are in R/W memory, the system monitor will store interrupt service subroutines in these locations.

Construction

Using the schematics (Fig. 1 and 2), you can construct the microcomputer using wire-wrap or solderless-breadboarding techniques. A complete set of

Interrupt input	Hex address	Octal address
RST0*	3F80	077 200
RST1*	3F88	077 210
RST2*	3F90	077 220
RST3*	3F98	077 230
RST4*	3FA0	077 240
TRAP	3FA4	077 244
RST5*	3FA8	077 250
RST5.5	3FAC	077 254
RST6*	3FB0	077 260
RST6.5	3FB4	077 264
RST7*	3FB8	077 270
RST7.5	3FBC	077 274

*External hardware, using the INTR interrupt input, will cause these interrupts to occur.

Table 4. Interrupt inputs and interrupt service subroutine starting addresses.

parts is available from Paccom, 14905 NE 40th Street, Redmond, WA 98052. If you wire-wrap, Paccom also sells just the hard-to-get parts (see price list).

When you're done, you should still be able to go through the construction steps to test your microcomputer a step at a time.

+12	A	1	+12
−12	B	2	−12
	C	3	
	D	4	
	E	5	
	F	6	
	H	7	
	J	8	
	K	9	
	L	10	
Solder side	M	11	Component side
	N	12	
	P	13	
	R	14	
	S	15	
	T	16	
	U	17	
	V	18	
	W	19	
	X	20	
+5	Y	21	+5
GND	Z	22	GND

Table 5. Edge connector signals on the 8085A CPU card.

Assuming you are using the PC boards, inspect the CPU card carefully before you solder any components to it. Look for bridging conductor paths and over-etched sections that may cause an open conductor.

Start the construction by installing and soldering filter capacitors C2 and C3, along with IC9, the LM320T−5.0 voltage regulator. Apply −12 V to pin 2 and ground to pin 22 of the edge connector (Table 5) and verify the operation of the voltage regulator by observing −5 V at pin 16 of IC11. Next, install and solder all of the IC sockets and remaining power-supply decoupling capacitors (C4-C13). Apply +5 V to pin 21 of the edge connector (ground pin 22) and verify the presence of +5 V on all of the pins listed in Table 6.

Remove all power from the CPU card and verify the continuity of the ground conductors between the ground pin of the edge connector (pin 22) and all of the IC pins listed in Table 7. During this test, no ICs should be installed other than IC9, the voltage regulator.

IC1, pin 40	IC2, pin 20	IC3, pins 13 and 24
IC4, pin 24	IC5, pin 24	IC6, pin 18
IC7, pin 18	IC8, pin 16	IC10, pin 16
IC11, pin 3		

Table 6. +5 V test pins on the CPU card.

Between pin 22 of the edge connector and:

IC1, pin 20	IC2, pin 10	IC3, pins 2 and 12
IC4, pin 12	IC5, pin 12	IC6, pin 9
IC7, pin 9	IC8, pin 8	IC10, pin 15
IC11, pin 14		

Table 7. Ground test points (continuity test) on the CPU card.

Wire the DIP header according to Table 3. The system monitor is only available in a 2708 EPROM, so if this program is to be used, wire the DIP header for use with 2708 EPROMs. This DIP header can later be changed if you want to use different EPROMs in your microcomputer system.

Plug the DIP header into the socket at IC11. Apply +5, +12 and −12 V to the appropriate edge connector finger (Table 7). You should be able to measure the following voltages at the DIP header: +5 on pin 3, +12 on pin 15 and −5 on pin 16.

If you use 2708 EPROMs in the microcomputer, verify the presence of −5 V on pin 21 of both sockets for IC4 and IC5. Also check for +12 V on pin 19 of both of these sockets. If you

8085A CPU kit	$149.95
Keyboard/display (I/O) kit	$99.95
8085A CPU and keyboard/display kit	$249.95
Completely assembled and tested CPU and keyboard/display (I/O) boards	$299.95
CPU printed circuit board	$22.00
Keyboard/display (I/O) board	$26.00
2708 monitor EPROM	$15.40
82S129 (or equivalent) PROM	$20.00
UDN2981A (or equivalent) display driver	$8.00
Keyboard and legend	$10.85
6.144 MHz quartz crystal	$5.55

Price list from Paccom, 14825 N.E. 40th St., Suite 340, Redmond, WA 98052.

use three-supply 2716s, check pins 21 and 19 of both IC4 and IC5 for −5 V and +12 V, respectively. If single-supply 2716s (5 volts only) are used, no connection should have been made to pins 15 or 16 of the DIP header.

Install the reset circuitry (R1, C1, D1 and PB1), the 6.144 MHz quarts crystal (XTAL1) and its associated capacitors (C14 and C15). Next, install the 1k pullup resistors, R2 through R8. The A and B jumpers (just below pin 1 and above pin 40 of the 8085A, IC1) should also be installed. The microcomputer will not operate without these jumpers.

Place the 8085A (IC1) in its socket and apply +5 V to the card (+5 V to pin 21, ground to pin 22 of the edge connector). Verify that the 8085A is operating by observing the high-frequency clock (>3 MHz) present on pin 37 of the CPU chip (IC1).

To test the CPU chip, install the 93427PC (or equivalent) PROM (IC8), R9–R11 (10k), the 8212 (IC3), the SN74LS245 (IC2) and the system monitor 2708 EPROM (IC4). Apply power to the microcomputer through the edge connector (+5, +12 and −12). If the microcomputer is working, it will generate a square wave on pin 4 of IC1 (the 8085A), with a period of about 1/2 second. A simple logic probe built from an SN74LS05, an LED and a 220 ohm resistor can be used to monitor this signal (Fig. 3).

Unfortunately, not all 8085A CPU chips reset properly when power is first applied. Therefore, you may have to press the reset push button (PB1) to reset the CPU.

After you remove power, install the two R/W memory chips (2114s, IC6 and IC7). Then apply power to the microcomputer. If all 1024 R/W memory locations are working, the voltage generated on pin 4 of the 8085A chip will not change (the pin may output either +5 V or ground). If R/W memory is not working, a 2 Hz square wave will be generated.

If R/W memory fails this test, substitute different 2114s for the ones plugged into the CPU card. If this doesn't fix the problem, remove all chips from the CPU card and check the continuity of the address, data and control signals between the 2114s and the 8085A, 93427PC PROM and the SN74LS245 sockets. Also look for shorts between adjacent signals.

Assembling the 20 mA Current Loop Circuitry (Optional)

If you are interested in using a teletypewriter or CRT rather

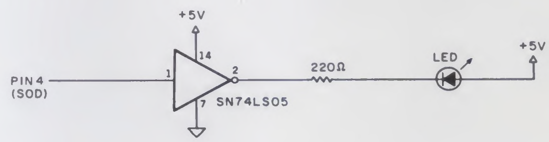

Fig. 3. Simple logic probe for use with pin 4 (SOD) of the 8085A.

than the keyboard/display board, add the 20 mA loop circuitry to the CPU board.

Solder the components (Q1, Q2, R12–R19 and C16) to the PC board. Take particular care to orient transistors Q1 and Q2 properly. Apply power to the microcomputer and connect an ammeter (set the scale to 50 or 100 mA) between the P+ and P− pads on the PC board. You should see no current or approximately 20 mA of current flowing every half second.

Before you test the keyboard portion of this circuitry, remove the 8085A chip. Using a voltmeter on a +5 or +10 V scale, attach the + lead to pin 5 of the socket for IC1 (where the 8085A is normally plugged in). Attach the - lead of the voltmeter to ground. Apply power to the microcomputer (all three voltages). You should see little, if any, voltage (0.8 V or less) on the voltmeter.

With a wire jumper, temporarily connect the K+ and K− pads on the PC board. Your voltage should be near +5 V, but not greater than +5 V. If you don't see any changes, look for shorts to ground or +5 V. If there aren't any, try replacing Q2.

Once both the transmitter and receiver sections of this circuitry are working, you can use short wire to solder the K+, K−, P+ and P− pads to any unused fingers on the edge connector (see Table 5). Once the jumpers are installed, note what signal has been wired to which edge connector finger in Table 5.

Keyboard/Display Construction

Check the keyboard/display board for any over- or underetched areas. Then solder resistors R20–R32 and capacitors C17–C19 in place. Solder the sockets for IC12, IC13, IC14 and IC24 and solder a socket for an LED display at IC16.

Before adding any chips or displays to this PC board, connect it to the CPU card with the 16 conductor DIP cable. There should be no twists in this cable (Fig. 4). Apply power to the CPU card (the keyboard/display board gets its power through the ribbon cable). Check for +5 V at pin 9 of IC13, pin 16 of IC14 and pin 26 of IC12. After turning the power off, press a seven-segment LED display into the socket for IC16 and press the UDN2981A into its socket (IC13).

Place a temporary jumper between pin 9 of the socket for IC14 (no chip is in this socket) and ground. Apply power to the system and temporarily connect pins 2, 3, 4, 5, 6, 7 and 8 of the UDN2981A to +5 V, using a clip lead or jumper wire. As each pin is wired to +5 V, you should see a different segment of the LED display turned on. Once each segment has been tested, remove power.

Each pin (2–8) of the UDN2981A should only be wired to +5 V long enough so that each segment within the display is tested. If a pin is wired to +5 V for too long (ten or more seconds), the segment may burn out.

This test verifies the operation of the UDN2981A segment driver (IC13) and the current limiting resistors (R20–R26; 39 ohm). At this point, remove power.

Solder the remaining sockets for the LED displays in place. If you are going to use hexadecimal numbers, solder sockets in positions IC16 (already done), IC17, IC18, IC19, IC20 and IC21. If you are going to use octal numbers, solder all nine sockets in place (IC15–IC23). If you are going to use hex numbers, the three additional sockets and displays can be added later, without changing the system monitor EPROM or any other circuitry.

Once you've soldered these sockets, install the LED displays. Jumper pin 4 of the socket for IC12 (the 8255A chip must not be in its socket) to +5 V with a clip lead. Apply power to the system and successively ground pins 1, 2, 3, 4, 5, 6, 7, 9 and 10 of the socket to be used for IC14 (the SN74145 must not be in its socket). Observe that the top-most segment in each display is lit, going from left to right, as the different pins of the socket for IC14 are grounded. Once you've done this test, remove power from the system.

Place the SN74145 (IC14) in its socket. The jumper between pin 4 of the IC12 and +5 V should still be in place. Now jumper pin 12 of the SN74145 to ground. Apply power and observe that the top segment of IC16 is lit. This tests a portion of the SN74145 decoder. Remove all jumpers and turn the power off.

Since no other functions on the keyboard/display board can be easily tested without the microcomputer, carefully bend the wires of the keyboard (KYB1) and solder the keyboard in place. Strip the paper backing off the keyboard legend and press the legend onto the keyboard, according to Fig. 5. Press the 8255A PPI chip into its socket, taking care to note the orientation of the chip (pin 1).

Power up the system. The microcomputer should display "8085 uP." Since the CPU card contains power-on reset circuitry, it will take the microcomputer about half a second to reset and then display this information. This delay will always occur whenever the microcomputer is reset (by turning on the power or by pressing the reset push button).

If "8085 uP" is not displayed, press the reset button. If, after a short delay, "8085 uP" is still not displayed, turn the power off and check that all of the integrated circuits and LED displays are in their sockets correctly. Also make sure that the DIP cable properly interconnects the two boards (Fig. 6). Reapply power.

If the microcomputer is displaying data other than "8085 uP," either a chip or chips are not properly in their sockets, or a chip is not functioning properly. Since much of the system has already been tested, the 8255A PPI chip may be at fault.

If nothing is displayed, the 8255A PPI chip or the 93427PC PROM may be the problem. Remove the 93427PC (or equivalent) PROM and the 8255A PPI chip and check for continuity between pin 9 of the 93427PC's socket and pin 6 of the socket for the PPI chip. If this connection is good, remove all of the chips from the CPU card and verify the continuity of the data, address and control signals to the I/O header (IC10) through the DIP cable and up to the 8255A PPI chip socket (IC12) on the keyboard/display board.

Using the System Monitor

Once the microcomputer displays "8085 uP," press one of the keys between 0 and 7 to use octal numbers or any other key to use hex numbers.

When a key is pressed, the microcomputer displays the address of the first R/W memory location, along with its contents, in either hex or octal. Therefore, the microcomputer displays either 3C00 XX or 074000 XXX, where XX or XXX is the content of this R/W memory location. Since the content of R/W memory is lost when power is removed from the microcomputer, there is no way to predict what will be contained in this memory location.

At this point, the system monitor can examine and modify (if required) the content of memory and the content of the general-purpose registers, execute a program, set and remove a breakpoint or execute a single instruction contained in your program.

Memory Address Command

Before the memory content is examined, you must specify a 16-bit memory address as either a six-digit octal or four-digit hex number. Enter the high byte of the address (the eight most-significant bits) and press the H key, and/or enter the low byte of the address and press the L key. Once either the H or L key is

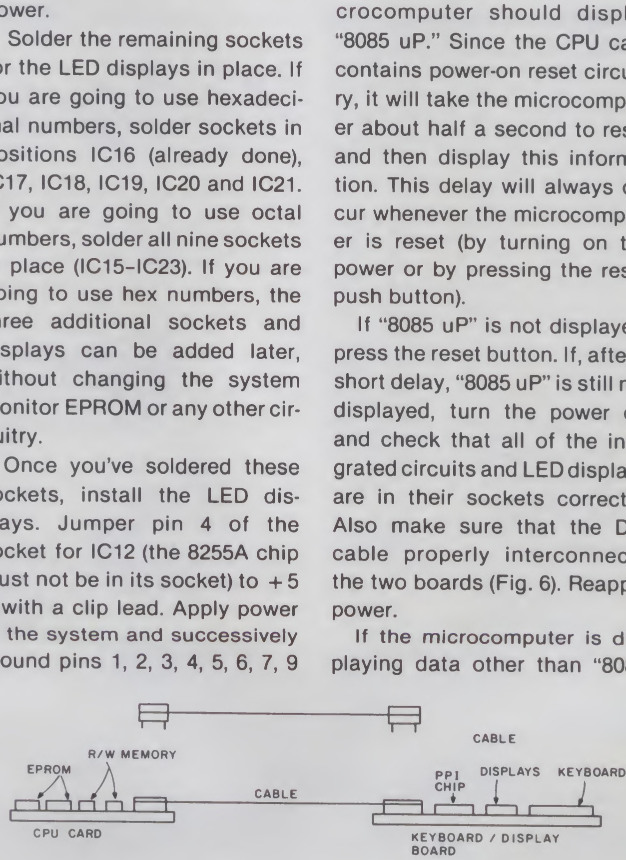

Fig. 4. Proper cable orientation between the CPU card and the keyboard/display board.

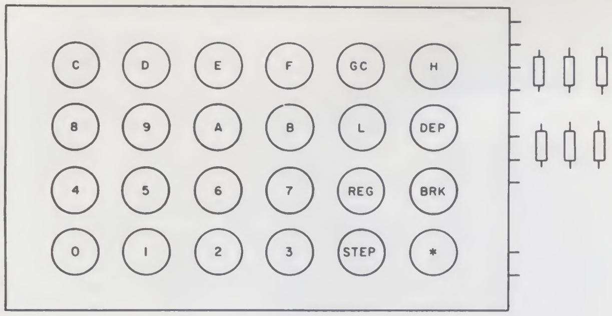

Fig. 5. Positioning the keyboard legend.

pressed, the new memory address and the content of this memory location will be displayed.

Memory Examination Command

Once the high and low portions of the memory address are specified, the contents of the specified memory location are displayed. To examine the content of the next consecutive memory location at a higher address, you could enter its low address and press the L key. However, if you press the DEP key, the 16-bit memory address is incremented by one and this new address, along with the content of memory at this address, is displayed. By pressing the DEP key a number of successive times, you can examine a continuous segment of memory.

Memory Change Command

Once the high and low portions of the memory address are specified the content of the memory location will be displayed. To change the content of this memory location, you enter the appropriate hex or octal numbers. This numeric information is displayed on the rightmost two (hex) or three (octal) (DATA) LED displays. If you make a mistake as the numeric information is entered, simply keep pressing the octal or hex keys until the proper number is displayed.

At this point, the new numeric information has not been stored in memory. To store this information, you must press the DEP key. The new numeric information will be stored in memory, the memory address will be incremented by one, and the content of this memory location will then be displayed.

The DEP key examines the contents of consecutive memory locations, and, if new numeric information has been entered, this information is stored in memory and the memory address is incremented. Therefore, you can think of the DEP key as representing the deposit function.

Examining/Altering the Content of Registers

To examine and possibly alter the content of one of the 8085A's general-purpose registers, you must press the register (REG) key. The microcomputer responds by displaying "A" along with the content of the A register. By pressing the deposit (DEP) key, you can examine the content of the other general-purpose registers and the flag word.

If you must alter the content of a register, the register's name—A, B, C, D, E, H, L or F (for the flags)—must be displayed, along with its contents. At that point you can enter new numeric information on the keyboard, which will be saved in the register when you press the DEP key. Therefore, use the DEP key to examine and modify both consecutive memory locations and the general-purpose registers. To return to the system monitor, simply press the REG key.

Executing a Program

To execute a program, you must specify a 16-bit memory address. Therefore, when you press the GO key, the 8085A starts to execute the program

stored in memory, as specified by the 16-bit address being displayed. If you press the GO key immediately after the 8085A is reset, the 8085A begins to execute the program stored in R/W memory starting at 3C00 or 074000. Of course, by using the H and L keys, any starting address can be displayed (specified) for the GO command.

Setting a Breakpoint

To set a breakpoint in the program stored in R/W memory, press the break (BRK) key when the appropriate address is displayed.

For instance, to set a breakpoint at memory location 3D45, you press the keys 3, D, H, 4, 5, L and the BRK key. This sequence displays the address 3D45, along with the content of this memory location. When you press the BRK key, the content of the memory location changes to FF (377), which is the breakpoint instruction (a RST7). When you hit the breakpoint (you started executing the program with the GO key), the breakpoint instruction is removed and your original instruction is written back into the appropriate memory location.

Note that a breakpoint must only be "set" at the memory location that contains the op-code of an instruction. You'll get unpredictable results if the breakpoint is set on the data or address bytes of multi-byte instructions.

Removing a Breakpoint

At some point, you may set a breakpoint and execute a program without the breakpoint being reached. If this happens, you can manually remove the breakpoint by specifying the breakpoint address and writing the original instruction back into memory.

However, if a breakpoint is never reached by the program, press the BRK key to remove the breakpoint. Therefore, you use the BRK key to remove a breakpoint if one is set, or set a breakpoint if one is not.

Breakpoint Features

Use a breakpoint only when you need to know what the status of the microprocessor is when a certain instruction is reached. Therefore, when a breakpoint is set and reached by the microcomputer, the 8085A displays the address of the breakpoint and the original contents of this memory location.

At this point, you can use the REG key to examine and/or modify the content of the general-purpose registers. Then you can set the breakpoint at another point in memory and press the GO key to continue program execution. Also, you can press the step key, so that the microprocessor executes the next consecutive instruction.

Single-Stepping the Microprocessor

Once a breakpoint is reached you can instruct the microprocessor to execute a single instruction, regardless of its length, by pressing the step key. The next instruction is executed and the microcomputer displays the address of the next instruction and its op-code. The content of memory or the content of the general-purpose registers can be examined and/or altered.

Conclusion

The microcomputer described in this article is small but versatile. It can be used as a dedicated controller in a number of applications or as a general-purpose programming, debugging and interfacing tool. By using 2716 EPROMs with the microcomputer, it can be powered by battery, which means that it can be used in automotive or remote-site data acquisition applications.

The microcomputer can also be easily interfaced to a teletypewriter, CRT or even another microcomputer, using the 20 mA, asynchronous serial interface. By communicating with another microcomputer, down-line loading and satellite-microcomputer operations are possible.

This article has been excerpted from *The 8085 Cookbook*. If you are interested in 8085A-based microcomputers but would like to design your own using decoders, EPROMs and R/W memories and other devices, you should refer to *The 8085 Cookbook*. It is available from Group Tech, PO Box 87N, Check, VA 24072, for $13.95, postpaid. ■

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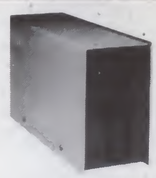

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Modification of a Level III modification.

W. R. Stanley
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In his fine article, "More TRS-80 Horsepower" (*Kilobaud Microcomputing*, October 1979, p. 72), Ronald Cowart outlined a procedure for obtaining both Level I and Level II operations in your TRS-80, and stressed that the undertaking would be successful only if a single-chip Level I ROM is used in that conversion. However, that single chip is not readily available.

My Level I TRS-80 (now upgraded to 16K Level III) had two ROM chips on a Suffix G board. Information contained in the *TRS-80 Technical Reference Handbook* leads one to believe that there have been several suppliers for the Level I ROM chips, and that there is no direct correlation between the printed board suffix letter and either the supplier of or the number of Level I chips used in a particular TRS-80. My modification calls for using two Level I chips to enable the TRS-80 to function as a Level III machine.

Initial Checkout

If you have already added Level II to your computer but would still like to have Level I available—but you have a two-chip Level I ROM set—don't give up. First, carefully inspect the main printed circuit board. If there are no factory-installed jumpers or etch cuts in the vicinity of the ROM sockets Z33 and Z34, you are halfway home. Certain letter-suffix boards were factory-modified to accommodate two-chip Level I ROMs from specific suppliers.

Second, carefully unplug (at Z33) the ribbon cable to the Level II board. Reinsert your pair of Level I chips in the ROM sockets. It should make no difference which chip goes in which socket. Run the computer to make sure you still have proper Level I operation.

If you reconfigured the jumpers at Z3 according to Cowart's article, you tied the ROM A and ROM B enable lines together. If your ROM chips are like mine, they won't interfere with each other. If you cannot get proper Level I operation with both ROMs enabled, you are on your own to develop an address decoder or some other approach to achieve compatibility.

Modification

If all checks out well, mount two 24-pin sockets side-by-side on a piece of perfboard the same width as the Level II ROM board and just long enough to hold the two sockets. I sawed a chunk of the right size from a Radio Shack Cat. No. 276-154 card. The 276-152 card will also do the job.

Remove the foam support from the Level II board at the ribbon socket end and epoxy the small board to the Level II board. Make sure that the appropriate pins on the added sockets are lined up with the corresponding pins on the ribbon socket.

With the exception of pin 20, solder jumpers between all three similar pins of the ribbon connector socket and the two added sockets. Install a jumper on pin 20 between the two added sockets, but do not connect to pin 20 of the ribbon socket. Instead, run a lead from this jumper to pin 5 of the switch shown in Fig. 2 of Cowart's article.

Do not connect switch pin 5 to Z33-20 as shown, and do not make the etch cut listed in step 4 of the Level III modification. Make all other connections and modifications detailed in the original article. Refasten the foam-rubber support to the small board, recheck all wiring and button up the computer.

If you have T-BUG or some other monitor program loaded while in Level I operation, you can access the Level I ROM at both addresses 0000H–0FFFH and 2000H–2FFFH. The computer won't get confused in Level I, however, since all the ROM calling and jump addresses are still below 0FFFH. Changing the address decoder output jumpers at Z3 to accommodate Level II brings about this seemingly improper ROM addressing. ■

KILOBAUD KLASSROOM NO. 20

EPROMs and Troubleshooting

Peter A. Stark
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Mt. Kisco, NY 10549

In the June 1980 issue I described the basic construction of the Kilobaud Klassroom Komputer. Next month I'll discuss its programming and how to expand it for more memory or more I/O capability. But first, I'll need to discuss EPROM programming and how to troubleshoot the basic system if it doesn't work.

Computer Memory Organization

The addresses assigned to each part of the computer are determined by the wiring of the 74LS138 address decoder (see Fig. 9 of the June issue, p. 30) and the internal memory of the 6802. The address organization looks like this:

0000-007F—128-byte RAM inside the 6802
0080-7FFF—not used
8000-9FFF—ACIA (if used)
A000-BFFF—PIA 1
C000-DFFF—PIA 2 (if used)
E000-FFFF—2716 EPROM

The 6802 can handle a total of 64K addresses; the 74LS138 splits this up into eight 8K segments and provides a negative-going pulse on one of its outputs whenever a corresponding memory or I/O address is encountered. These pins (Fig. 9 of the June installment) are as follows:

Pin 15—0000-1FFF
Pin 14—2000-3FFF
Pin 13—4000-5FFF
Pin 12—6000-7FFF
Pin 11—8000-9FFF (to ACIA if used)
Pin 10—A000-BFFF (to PIA 1)
Pin 9—C000-DFFF (to PIA 2 if used)
Pin 8—E000-FFFF (to 2716 EPROM)

Thus, these output pins can be used to address other I/O equipment or memory you might consider adding.

Although the PIA, ACIA and ROM are each assigned an 8K address segment, each actually uses a much smaller amount; many addresses are wasted due to incomplete address decoding. For example, an ACIA uses just two addresses. Thus, a program referring to the ACIA could use addresses 8000 and 8001; all the other addresses in the range from 8002 to 9FFF would simply refer to the same two locations.

I alluded to this last time in relation to the addresses used by the EPROM. Although the 2716 EPROM has only 2K locations, it uses up a full 8K of addresses (from E000 to FFFF). Within that 8K, the 2K contents repeats itself four times. For instance, the first location of the EPROM is at location E000, but also appears at E800, F000 and again at F800.

To keep the situation simple, think of the EPROM as occupying just one set of addresses. I think of it as occupying addresses F800 through FFFF.

This is complicated by one factor. If you have someone else program the 2716 for you, he will generally think of the EPROM as being addressed as 2K locations starting at 0000 and going through 07FF. Thus, if you want location F934 programmed to 15, your address F934 is really F934 minus F800, or 0134 within the EPROM.

If this seems too complicated, think of your EPROM as occupying addresses E000 to E7FF, or perhaps F000 through F7FF. This certainly makes the translation easier for the person programming the EPROM.

I prefer F800 simply because my EPROM programmer, which runs on an SWTP 6800 computer, uses a memory area from 0800 through 0FFF as a buffer for the data to be programmed. Thus, F800 translates into 0800, and so on.

Programming the 2716 EPROM

Since the program to be performed by our computer resides in a 2716 EPROM, the next problem is to find out how to put that program into the 2716 in the first place.

Although the 2716 cost as much as $75 just a year ago, it has recently dropped below $20 and seems to be dropping still. For experimenting, you may also be interested in a 2758 EPROM, which is sometimes sold for less than $10. The 2758 is essentially a defective 2716. It is specified as being a 1K × 8 EPROM, but is actually a 2K × 8 EPROM with a few defective locations in the second 1K. If you can work around the bad locations, you can use it almost as well as the 2716.

The easiest way to program the 2716 (or 2758) is with an EPROM programmer. Although programming an EPROM does not involve burning anything, such a programmer is often called a PROM burner or PROM blaster, since some other kinds of PROMs are programmed by burning out a fuse. We also often talk of burning a PROM for that reason.

A commercial programmer is either a self-contained device, or, more usually, an add-on to an existing computer that uses that computer to control programming and hold the data to be programmed.

In general, a programmer needs at least 2K of RAM to hold the data that will be programmed into the EPROM. This data is first fed into the RAM, where you can check it to make sure it is correct before it is committed to the EPROM. Once correct, it is automatically transferred into the EPROM by the programmer; after programming, the EPROM can usually be verified to make sure that the data stored in it is an exact copy of the data in RAM.

Many individuals and computer clubs have 2716 programmers available. Frequent ads in computer magazines or in classified newsletters such as *Computer Shopper* also offer programming services at low cost. (I can also erase or program into your 2716 those programs printed as part of the Kilobaud Klassroom only, for $5 per EPROM. But to keep down the load, please try other programming sources first.)

If you are careful (and only as a last resort!) you can program a 2716 EPROM on a jury-rig circuit

wired on a prototype board. But I don't recommend entering data and addresses from switches since it is unlikely that you could program a full 2K locations without a single mistake. (Moreover, one false step and you can burn out a $20 EPROM.)

If you insist on programming one without a programmer, though, it is possible (though only practical for small amounts of data). First of all, you will need a spec sheet and programming information for the 2716. The most accessible is the *Intel Component Data Catalog*, or the *Intel Memory Catalog*, available at Radio Shack for a few dollars.

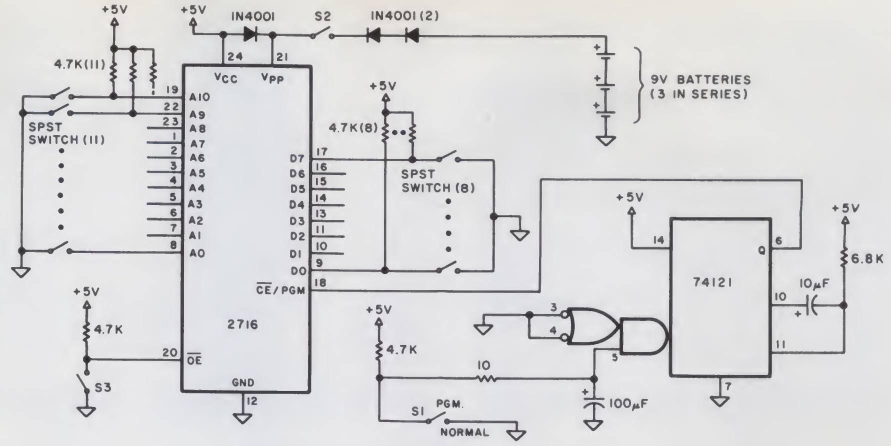


Fig. 1. 2716 Programming Circuit.

Fig. 1 shows a circuit you could wire on a prototyping socket or on your Kilobaud Klassroom console for programming a 2716. To be successful, you must make sure the circuit is correct, and also go through the right procedure in the right order.

The procedure essentially goes like this:

1. Start with S2 open, but S1 and S3 closed. Then plug the 2716 into the circuit.

2. Apply +5 volts power to Vcc (pin 24).

3. Close switch S2 to apply between 24 and 26 volts to Vpp (pin 21). Less than 30 mA is required, so not much of a power supply is needed. In Fig. 1, three 9-volt batteries in series, plus two 1N4001 silicon diodes also in series to drop the resulting 27 volts back to about 25½ volts, are an acceptable substitute for a separate power supply.

4. *Place the address to be* programmed on the address pins, and the data to be entered on the data pins. Fig. 1 shows 11 SPST switches connected to the address pins and eight switches connected to the data pins. Small multi-pole DIP switches are the easiest to wire into this circuit. In any case, a closed switch places a ground or 0 on the appropriate pin, while an open switch places a 1 on the pin by allowing the 4.7k pullup resistor to pull the EPROM pin up to +5 volts.

5. Bring $\overline{OE}$ (pin 20) high by opening switch S3.

6. Open and then again close switch S1 to feed a 50 ms wide positive pulse to $\overline{CE}$/PGM (pin 18). This is the pulse that programs the current location. Since 50 ms is a fairly narrow pulse, it should come from a one-shot or a computer-controlled port; it cannot come just from a switch, for it would be too wide.

In this case, I use a 74121 one-shot to generate the 50 ms pulse, whose width is set by the capacitor and resistor connected to pins 10 and 11. The trigger input from the switch is applied to the IC through an RC (resistance-capacitance) combination that eliminates switch bounce; this assures that the one-shot will generate only one pulse about a half-second after the switch is opened.

7. Bring $\overline{OE}$ back to ground by closing switch S3.

8. If more locations are to be programmed, repeat steps 4 through 7 as often as necessary.

9. Finally, turn off Vpp and Vcc. But observe the following precaution—never apply the 25-volt Vpp supply unless the EPROM is also getting +5 volts Vcc. In other words, connect Vcc first and then Vpp; at the end, disconnect Vpp first, then Vcc.

After programming each location, it is a good idea to check that the data has been correctly stored. If your logic breadboard has eight LED logic indicators, these can be left connected to the eight data pins during programming. Right after step 7, with $\overline{OE}$ back at a low, you can open switch S2 to remove Vpp from the EPROM (the diode between pins 24 and 21 then supplies +5 volts to Vpp), and then also open all eight of the switches connected to the data output lines. The data should remain on the EPROM output pins if they have been correctly stored.

Though the above procedure will work, do everything you can first to find someone who will program the 2716 for you. If you already own a computer, then a 2716 programmer that works with that computer may be a reasonable investment. As an alternative, the circuit of Fig. 1 can be easily interfaced to three parallel output ports (used instead of switches) to automate the entire process.

Erasing the EPROM

The 2716 EPROM has a small window in the middle of the package, just above the IC chip itself. It is erased by shining a strong beam of ultraviolet (UV) light through the window on the chip. Data is stored in the IC as a charge on the gate of an FET transistor, and the strong UV light causes this charge to leak off and disappear.

Commercial erasers consist of a small UV fluorescent bulb mounted in a small case. In operation, the EPROM is placed inside and sits about one inch away from the bulb. Then the cover is closed, and the UV bulb turned on for about 30 minutes.

Commercial erasers cost $40 and up. I erase with a less expensive, though more awkward and dangerous *method. There* are a number of "germicidal" fluorescent tubes designed to kill germs by exposure to high intensity, short wavelength UV light. These tubes come in various sizes. One of them (GE type G15T8) is a 15-watt tube that fits into a standard 15-watt fluorescent desk lamp. I simply put this tube into my regular desk lamp, prop the EPROMs to be erased on some boxes to get them within one inch of the tube and leave the light on for 30 minutes. But this process is highly dangerous.

Germicidal bulbs are designed to kill germs; they will also kill live cells in your skin or eyes. It is essential that this UV light does not reach your skin or your eyes. I turn on the fluorescent light, leave the room (with my eyes closed) and lock the door.

Despite these precautions, I once managed to erase several EPROMs *installed in* my computer (which is at the opposite side of the room) when I forgot to cover it. Thus, using a bare UV bulb in this fashion is not only dangerous, but also inconvenient.

Preliminary Tests

Troubleshooting a defective computer can sometimes be difficult without the proper test equipment. Fortunately, a printed circuit board eliminates most chances of a wiring error. Nevertheless, it pays to spend a few extra moments checking for some common problems before

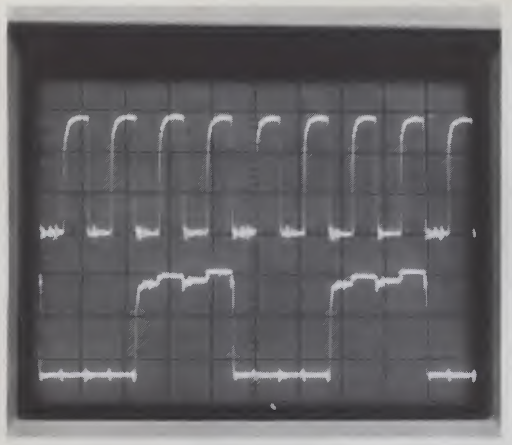


Photo 1. Enable clock (top) and VMA (bottom) signals during execution of the short 20 FE loop discussed in the text.

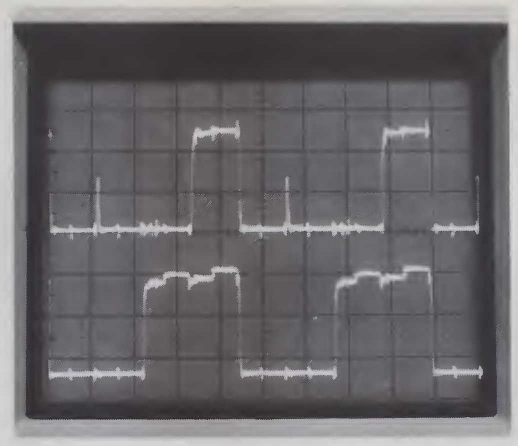


Photo 2. Address bus bit A0 (top) and VMA (bottom) signals during execution of the short 20 FE loop discussed in the text.

turning everything on and perhaps damaging an IC or two.

Before plugging the ICs into your circuit, use an ohmmeter to check the resistance between adjacent pins on all IC sockets. If a low resistance is measured at any point, check the diagrams to make sure it is OK. (For example, a number of adjacent 6802 pins are supposed to be connected together to +5 volts.) If there are unexpected low-resistance readings, check the board for solder bridges.

Next, still with no ICs plugged in, connect power to the board and check that the voltage regulator is providing an output between about 4.8 volts and 5.2 volts. If the supply voltage is outside these limits, find the cause of the problem before proceeding; otherwise, you may get some fried chips.

If you are using an external power supply, be absolutely sure that the polarity is correct—reversing plus to minus can quickly ruin a chip.

Now turn off the power, plug in just the 6802 and reconnect power. Using an oscilloscope, frequency counter or logic probe—in that order of preference—check that there is a signal on pin 38 of the 6802 at the crystal frequency; pin 37 should have a signal at one-quarter of the crystal frequency. (With the recommended 3.579 MHz color TV crystal, pin 38 should have a signal at 3.579 MHz, and pin 37 should have a signal of about 895 kHz.)

These signals should be clearly visible on a scope. A frequency counter will also tell you if they are there, while a logic probe will indicate a signal but not its frequency. Still, this is an adequate indication. (The top trace in Photo 1 is the enable clock signal on pin 37.)

When using a counter, you might get an incorrect reading for two reasons. First, the counter may simply not be sensitive enough to get a reading on pin 38—the reading may be 0, or else it may rapidly change between different and unrelated values. Second, the counter may exhibit a steady readout, but of an apparently wrong value. In most digital systems, the digital waveforms are not really neat square waves. Instead, they may have various degrees of distortion that produce ringing on edges, or small false pips that stick up or down from the pulse.

Though these may have no effect on the circuit, they will fool some sensitive counters into thinking that each pulse actually consists of two or three different pulses. Thus, a counter will often exhibit a reading that is two or three times the actual frequency. For this reason, engineers often use a calibrated oscilloscope as well as the counter, the scope to get an approximate reading and the counter to narrow it down to an exact value.

For example, if the scope indicates that the enable clock pulse is somewhere around 900 kHz while the counter reads 1789.5 kHz, the counter is probably reading each pulse twice, and so the exact frequency is half of 1789.5 kHz, or 894.75 kHz.

If these signals are absent, check that pin 40 is high. When the reset switch is closed, pin 40 should go to ground and then drift back high about a second after the switch is released.

• Troubleshooting Principles

This just about exhausts the tests that can be run without an actual program. An oscilloscope, even a good one, is not much use in debugging a microcomputer system unless there is a specific problem, such as a shorted or open line or a circuit loading down a line on a bus and preventing it from swinging through the full range from 0 to 1.

There are two reasons why scope display of microcomputer waveforms is not that helpful. First, the waveforms on the data or address bus, as well as on other control lines, tend to be quite complex and program-dependent; unless you know exactly what your program is doing, it's difficult to figure out the scope display. Second, dozens of simultaneous signals are usually changing all at once, while the typical oscilloscope can only display one or two at a time.

The only reasonable way to use the scope to study the action on the data and address bus is to force the computer into executing a short program over and over, so that the signals repeat and can be studied one or two at a time.

For example, if you tie up the computer in a one-step loop as discussed in the next section, then you can see waveforms as in Photos 1 and 2. Photo 1 shows the enable clock pulse at the top and VMA at the bottom; Photo 2 shows address bit A0 at the top and VMA at the bottom. By displaying VMA in both pictures, you can get an idea of the relative timing between all three waveforms. Note that none of the waveforms are really as square as diagrams in articles and books often show them, and the top trace in Photo 2 even has a fairly large, pointed glitch.

Since any careful analysis of these waveforms really needs the information on relative timing, every photo would need one trace (such as VMA) as a refer-

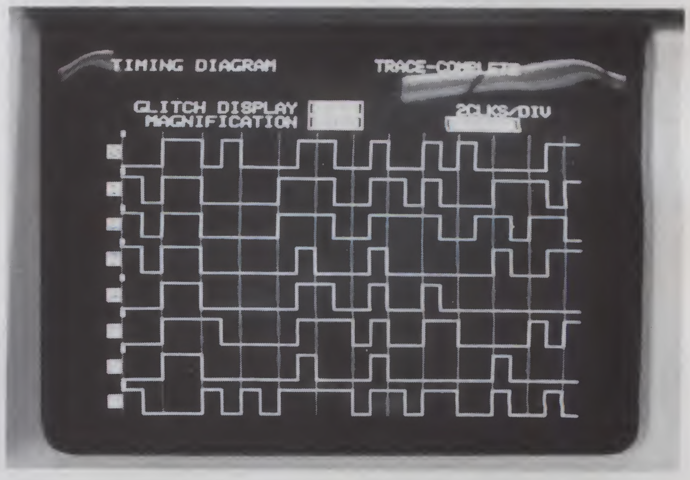


Photo 3. Idealized data bus waveforms displayed by a logic analyzer.

```
                 NAM   LISTING   1

               * THIS IS THE SIMPLEST PROGRAM THAT CAN BE RUN

   (FFF6)        ORG   $FFF6
FFF6 20 FE START BRA   *          ONE-STEP BRANCH LOOP

   (FFFE)        ORG   $FFFE
FFFE FF F6       FDB   START      POINT TO START ADDRESS

                 END
```

Listing 1. The simplest program that the computer can run for testing purposes.

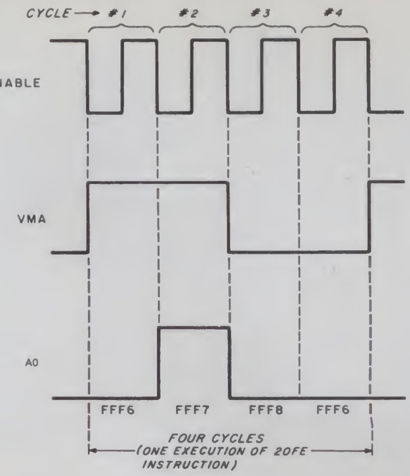


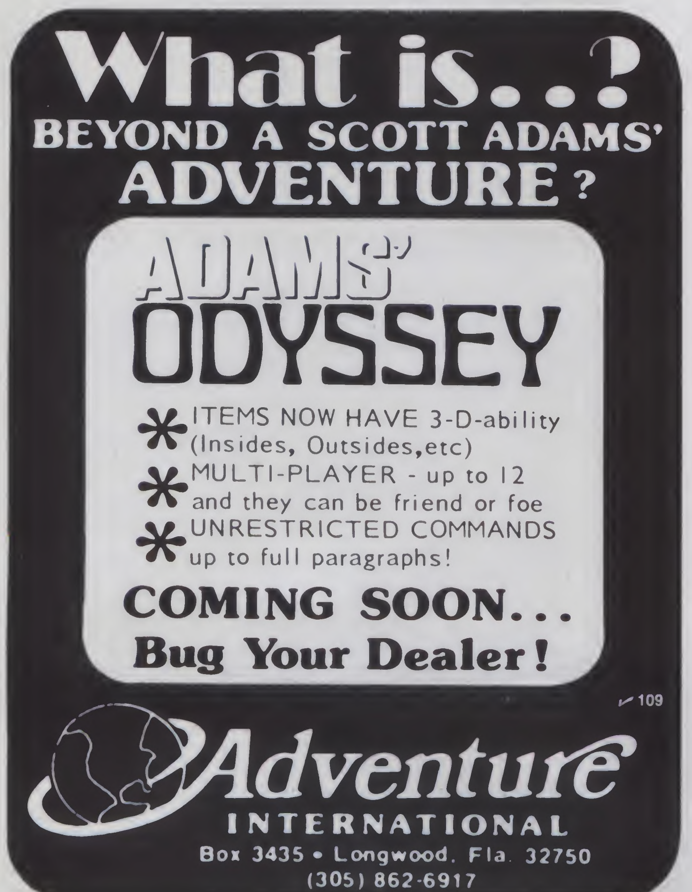
Fig. 2. Three waveforms shown in Photos 1 and 2.

ence to tie all the others together. Thus, to see all the action on just the eight-bit data bus would require eight photos.

For this reason, a number of instrument companies manufacture a special device called a logic analyzer, which examines all the bits on a bus at once. For instance, Photo 3 shows all eight bits of the data bus during a typical program. (The analyzer cleans up the waveform into neat, square waves, even though it doesn't really look like that.) But even here, seeing these waves means nothing if you don't know what program is being executed.

To do any serious kind of troubleshooting, you need to burn a special debugging program into a 2716 EPROM first. It doesn't pay to do this just to see whether the computer works; unless one of your ICs is bad, it probably does.

But since the purpose of the Klassroom is to educate, not necessarily be practical, let's see what program might be used if troubleshooting were needed.



Infinite Loop Program

The simplest program that our computer can run consists of just one instruction that ties it up in a loop (similar to 10 GOTO 10 in BASIC). This requires that you program four locations of the 2716 (Table 1). In this table, the location addresses in the first column are the addresses in our computer, while the addresses in the second column are corresponding addresses in the 2716.

An erased 2716 is full of 1 bits; that is, in hexadecimal every location of an erased 2716 has the number FF. Therefore, you don't even have to program location 07FE, since it already has the required FF.

Since a blank 2716 is full of 1s, programming changes those 1s to 0s. After it is programmed, it is possible to go back and, without erasing it first, program more 1s to 0s. Since the above program has so few zeros, it can later be wiped out and another program inserted without erasing it first. For instance, the FF F6 in the last two locations can be changed to F8 00, and so on, to hold another program.

Memory Location	EPROM Location	Contents
FFF6	07F6	20
FFF7	07F7	FE
FFFE	07FE	FF
FFFF	07FF	F6

Table 1.

Such a program is usually written with the aid of an assembler program. Rather than write directly in a numerical code, the programmer would first write his program using assembly language, and then let the assembler translate it to the numerical code, which is called machine language. Listing 1 shows this same four-byte program as it would be output by the assembler.

When a 6800 or 6802 processor is first started, as soon as its RESET line goes high, it fetches an address from the two top locations in memory. This address specifies the location of the first instruction to be executed. In our case, we place the number FFF6 into locations FFFE and FFFF to specify that the program starts at address FFF6. (But note that memory locations FFFE and FFFF are actually locations 07FE and 07FF when referenced to the beginning of the 2716 EPROM. It may be necessary to specify these addresses if someone unfamiliar with your system is programming the 2716 for you.)

In Listing 1, this is shown as the line

```
FFFE FF F6    FDB START  POINT TO
                         START ADDRESS
```

This means that you should place the two bytes FF and F6 into the two locations beginning at address FFFE (or 07FE within the EPROM). This is the part that will tell the 6802 where to find

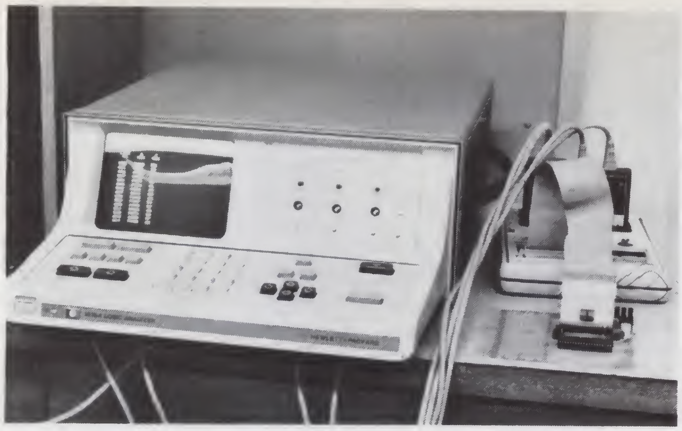


Photo 4. A Hewlett-Packard logic analyzer.

the beginning point of the program.

(Recall that you can later change this FFF6 to F800 without erasing the 2716. This would redirect the 6802 into starting a program at location F800 instead of FFF6, so you could then use the lower portion of the 2716 to hold another program.)

The program consists of the line

```
FFF6 20 FE    START BRA • ONE-STEP
                      BRANCH LOOP
```

which means that the instruction 20 FE should be placed into memory starting at address FFF6 (actually, locations 07F6 and 07F7 of the EPROM). This is an instruction that causes the computer to branch back and repeat the same instruction again. Thus, this forms a one-step loop that repeats itself over and over, much like 10 GOTO 10 in BASIC.

This program was running in the computer when Photos 1 and 2 were taken. With a little effort, you can see just what the waveforms in these two photos mean.

The top waveform in Photo 1 is the enable clock. This is usually called the phase Ø2 clock in 6800 systems and is the main clock signal for the entire system. Each cycle of the clock represents one machine cycle, which lasts about 1.11 microseconds with a 3.579 MHz crystal.

The 20 FE instruction is a short loop that takes exactly four machine cycles to execute. During the first two of those cycles VMA is high, and during the last two cycles it is low. Thus, the two photos show us nine machine cycles, or a little more than two executions of this instruction. The waveforms for just one instruction are shown in Fig. 2. (Keep in mind that this instruction repeats itself over and over since it forms a loop.)

During these four cycles, the 6802 does the following:

- Cycle 1—reads a 20 out of memory location FFF6.
- Cycle 2—reads an FE out of memory location FFF7.
- Cycles 3 and 4—internally computes where to GOTO next.

During these four cycles, it is outputting addresses FFF6, FFF7, FFF8 and FFF6 on the address bus as shown at the bottom of Fig. 2 (although valid memory address is only on during the first two cycles, and so only the first two addresses are actually used by memory). If we convert these addresses to binary, we see that FFF6 and FFF8 end with 0, while FFF7 ends with 1. This explains why address line A0 is high during the time when the address is FFF7, but is low elsewhere.

Although we could proceed like this to look at every single line of each bus, this becomes almost impossible with a program consisting of more than just a few instructions. Yet, when a computer seems dead and just doesn't want to do anything, it is sometimes necessary to do just this and analyze exactly what is going on for each cycle and each instruction. The professionals use a logic analyzer to make the job easy.

The Logic Analyzer

Photo 4 shows a Hewlett-

Packard Model 1615A Logic Analyzer, a fairly high-class unit. (With a price of about $8000, you don't find one in every lab!) The analyzer has an oscilloscope-like CRT screen, which is driven by an internal memory and quite extensive logic circuitry, which is controlled by a number of keys and switches on the control panel.

The analyzer connects directly to the pins of the microprocessor with either individual clips or via a clamp-on socket as shown in Photo 5. (Photo 6 shows individual clips connected to the pins of a wire-wrap socket; this photo shows the Paratronics Model 100A Analyzer with the Model 10 Expander Module, a combination that costs about $600 and is about the least expensive unit available.)

The logic analyzer connects directly to the microprocessor and receives all the signals on all the important pins. Inside the analyzer is a multi-bit memory, which can store all the bits on all the bus lines at every clock pulse.

For instance, the Hewlett-Packard unit shown has a high-speed 256 × 24 memory, which can store 256 different 24-bit numbers. Each of those 24-bit numbers consists of the eight bits on the data bus and the 16 bits on the address bus of a typical processor, so this analyzer can store all of the bus contents for 256 separate clock cycles.

Storage of this data is controlled by fairly complex circuitry in this analyzer. For instance, the storage can begin when a certain byte appears on the data bus or when a certain address appears on the address bus, and then the 256 next pieces of data are stored. Alternatively, data can be stored continuously, to be stopped when a specific bit combination appears on one of the buses, or some combination of the two. Thus, the analyzer's memory can hold the 256 states just before, just after or right around some specific event.

The contents of this memory can be displayed on the screen at any time. This is an area where a large difference exists between expensive and inexpensive analyzers. For example, the Hewlett-Packard analyzer can display all 24 bits of memory in either decimal, octal or hexadecimal as in Photo 7, or even in waveshape form as in Photo 3; the Paratronics analyzer can only store and display eight bits in binary, as shown in Photo 8.

Either way, however, the display is more useful than the information you can obtain from an oscilloscope. For example, Photo 7 shows the address bus (center column) and data bus (right column) as the following ACTESTER program is started; Photo 8 shows the data bus during execution of the 20 FE program above. If you convert each line to hexadecimal, you can see that the screen is showing

20
FE
FE
FE
20
FE
. .
. .

which shows the contents of the data bus for each of the four cycles of the program.

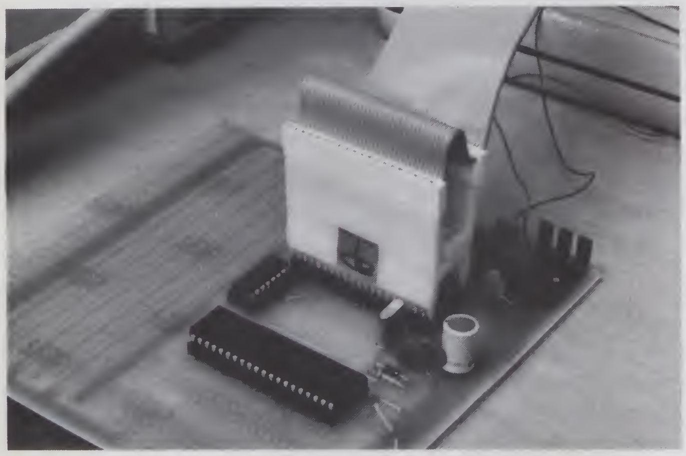


Photo 5. The logic analyzer connects directly to the microprocessor IC.

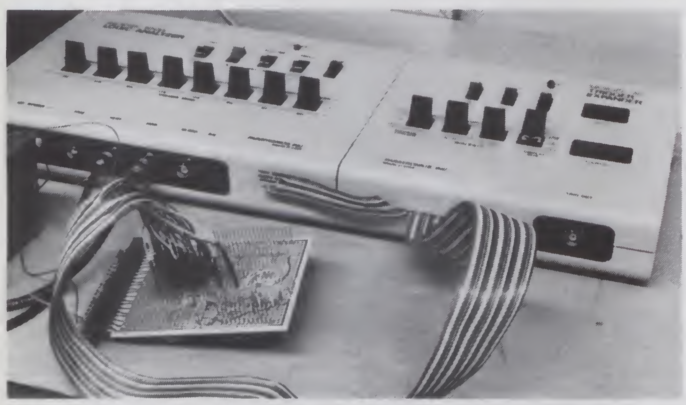


Photo 6. The Paratronics logic analyzer.

Photo 7. Hewlett-Packard analyzer display.

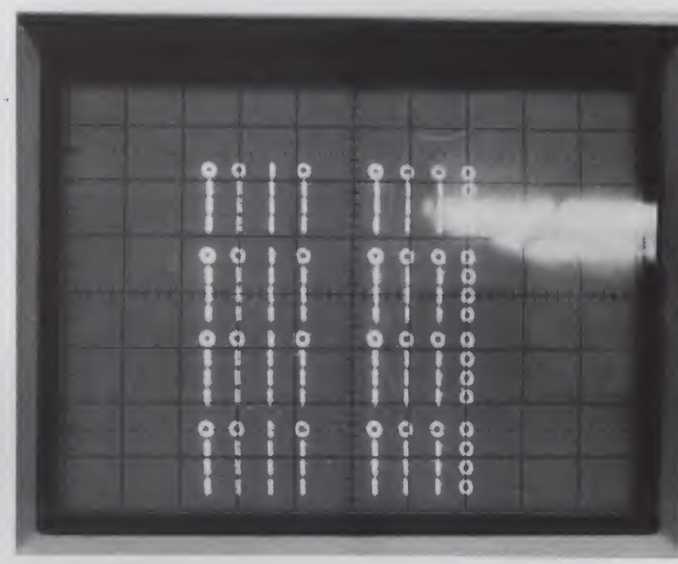


Photo 8. Paratronics analyzer display.

Listing 2. ACTESTER—the acoustic coupler test program.

```
                    NAM   LISTING   2

                    ***********************************
                    * ACOUSTIC COUPLER TESTER PROGRAM *
                    * FOR THE KILOBAUD KLASSROOM      *
                    * SINGLE-BOARD 6802 COMPUTER      *
                    ***********************************

                    * DEFINE MEMORY ADDRESSES FOR COMPUTER
   (F800)           ROM    EQU   $F800
   (0000)           RAM    EQU   $0000
   (007F)           STACK  EQU   $007F
   (A000)           PIA1   EQU   $A000
   (A000)           PIADRA EQU   PIA1
   (A001)           PIACRA EQU   PIA1+1

                    * RAM DATA
   (0000)                  ORG   RAM
0000                CHAR   RMB   1          CURRENT CHARACTER BEING TRANSMITTED
0001                BITCTR RMB   1          COUNTER FOR 8 BITS PER ASCII CHARACTER

                    * MAIN PROGRAM

                    * START AND INITIALIZATION
   (F800)                  ORG   ROM
F800 8E 007F        START  LDS   #STACK     SET STACK POINTER TO TOP OF RAM
F803 7F A001               CLR   PIACRA     RESET PIA CONTROL REGISTER
F806 86 FF                 LDA A #$FF
F808 B7 A000               STA A PIADRA     SET DIR REG A FOR OUTPUT
F80B 86 04                 LDA A #$04
F80D B7 A001               STA A PIACRA     TURN ON BIT 2 OF CONTROL REG

                    * SEND FIVE SECONDS OF 1 (MARK) BEFORE STARTING
F810 CE 0226        WAIT   LDX   #550       FIVE SEC TIMES 110 BITS PER SEC
F813 8D 2B          WAIT1  BSR   MARK       SEND OUT A 1
F815 09                    DEX
F816 26 FB                 BNE   WAIT1      AND REPEAT 550 TIMES
F818 CE F870               LDX   #TEXT      POINT INDEX REGISTER TO TEXT

                    * NOW SEND OUT THE NEXT CHARACTER
F81B A6 00          GO     LDA A 0,X        GET THE NEXT CHARACTER
F81D 97 00                 STA A CHAR       AND SAVE IT
F81F 81 04                 CMP A #$04       IS THIS THE END OF TEXT?
F821 27 ED                 BEQ   WAIT       YES -- WAIT AND REPEAT
F823 86 08                 LDA A #8         GET READY TO COUNT 8 BITS
F825 97 01                 STA A BITCTR
F827 8D 2F                 BSR   SPACE      SEND OUT START PULSE (0 = SPACE)
                    * MAIN SHIFT LOOP TO SEND OUT NEXT BIT
F829 74 0000        SHIFT  LSR   CHAR       MOVE NEXT BIT INTO CARRY
F82C 24 04                 BCC   SEND0      SEND OUT 0 IF CARRY=0
F82E 8D 10                 BSR   MARK       OUTPUT A 1
F830 20 02                 BRA   COUNT8
F832 8D 24          SEND0  BSR   SPACE      OUTPUT A 0
F834 7A 0001        COUNT8 DEC   BITCTR     HAVE WE SENT 8 BITS?
F837 26 F0                 BNE   SHIFT      NO -- GO BACK TO SEND NEXT BIT
F839 8D 05                 BSR   MARK       YES -- SEND OUT A STOP BIT
F83B 8D 03                 BSR   MARK       AND ANOTHER STOP BIT
F83D 08                    INX              POINT INDEX TO NEXT CHARACTER
F83E 20 DB                 BRA   GO         AND GO BACK TO SEND NEXT CHAR

                    * SUBROUTINE TO SEND OUT A MARK (1)
                    * SEND OUT 20 CYCLES OF 2225 HZ; EACH HALF-CYCLE
                    * IS 201 MACHINE CYCLES AT A .8947 MHZ CLOCK FREQ.

F840 C6 14          MARK   LDA B #20        SEND 20 CYCLES
F842 86 01          MARK1  LDA A #1
F844 B7 A000               STA A PIADRA     POSITIVE HALF-CYCLE
F847 86 20                 LDA A #32        SET UP WAIT LOOP
F849 4A             MARK2  DEC A
F84A 26 FD                 BNE   MARK2      WAIT
F84C 7F A000               CLR   PIADRA     NEGATIVE HALF-CYCLE
F84F 86 1F                 LDA A #31        SET UP WAIT LOOP
F851 4A             MARK3  DEC A
F852 26 FD                 BNE   MARK3      WAIT
F854 5A                    DEC B            NEED MORE CYCLES?
F855 26 EB                 BNE   MARK1      YES -- GO BACK
```

```
F857 39              RTS            NO -- SO EXIT

                * SUBROUTINE TO SEND OUT A SPACE (0)
                * SEND OUT 18 CYCLES OF 2025 HZ; EACH HALF-CYCLE
                * IS 221 MACHINE CYCLES AT A .8947 MHZ CLOCK FREQ.

F858 C6 12      SPACE  LDA B #18        SEND 18 CYCLES
F85A 86 01      SPACE1 LDA A #1
F85C B7 A000           STA A PIADRA     POSITIVE HALF-CYCLE
F85F 86 24             LDA A #36        SET UP WAIT LOOP
F861 4A         SPACE2 DEC A
F862 26 FD             BNE   SPACE2     WAIT
F864 7F A000           CLR   PIADRA     NEGATIVE HALF-CYCLE
F867 86 22             LDA A #34        SET UP WAIT LOOP
F869 4A         SPACE3 DEC A
F86A 26 FD             BNE   SPACE3     WAIT
F86C 5A                DEC B            NEED MORE CYCLES?
F86D 26 EB             BNE   SPACE1     YES -- GO BACK
F86F 39                RTS              NO -- SO EXIT

                * TEXT TO BE PRINTED OUT
F870 0D         TEXT   FCB   $D,$A,7,0,0,0
F876 54                FCC   'THIS IS THE KILOBAUD KLASSROOM 6802 '
F89A 53                FCC   'SINGLE-BOARD COMPUTER'
F8AF 0D                FCB   $D,$A,7,0,0,0
F8B5 4E                FCC   'NOW IS THE TIME FOR ALL GOOD MEN TO '
F8D9 43                FCC   'COME TO THE AID OF THEIR COUNTRY.'
F8FA 0D                FCB   $D,$A,0,0,0
F8FF 54                FCC   'THE FOX JUMPED OVER THE LAZY DOG'
F91F 0D                FCB   $D,$A,0,0,0
F924 30                FCC   '0123456789!"#$%&'
F934 0D                FCB   $D,$A,0,0,0
F939 04                FCB   4

                * 6802 RESET VECTOR AT FFFE-FFFF POINTS TO START

  (FFFE)               ORG   $FFFE
FFFE F8 00             FDB   START

                       END
```

You don't need a logic analyzer, of course, when the computer is running normally. But there are times when a computer is absolutely dead, yet a quick examination of the buses with a scope shows that waveforms exist and something is going on. But what? The computer might be caught in a loop, or it might not be able to execute anything because two bus lines are shorted, or whatever. But the logic analyzer, by monitoring the buses, can be used to discover just what is happening.

ACTESTER— A More Complex Program

I'll start examining programming next time, but if in the meantime you'd like to see what the computer can do, Listing 2 shows a more complex program.

This program takes the text message stored in memory locations F870 through F939 (which reads THIS IS THE KILOBAUD...), converts each character into serial ASCII, adds a start bit in front and two stop bits in back and outputs it via bit PA0 (pin 2) of the PIA in serial at 110 baud, exactly the way as it might come out of a serial terminal. But there is a slight difference—instead of being output as pure pulses, the output comes as a 2225 Hz square wave for a 1 and a 2025 Hz square wave for a 0.

These frequencies are the same ones that would be received by an originate acoustic coupler from a remote computer. You can connect pin 2 of the PIA to a signal tracer or amplifier and easily hear the digital output. If you have an acoustic coupler and terminal, just place the speaker close to the coupler, and your terminal will spring to life and print the message. This program makes a convenient tester to check whether your acoustic coupler is working properly.

This is a neat demonstration program and is a good way of making sure that the computer is working properly. With a little work, it can be modified to input data from an inexpensive parallel keyboard via port B of the PIA, convert the data to serial and output it in FSK to either a telephone line or, better yet, to a cassette recorder. Now you could mount this computer inside the keyboard case; if you wanted to do some data or program entry on a vacation or business trip, just take the keyboard and a cassette recorder with you, and type away. When you get home, simply read the tape back into an acoustic coupler.

Next Klassroom I'll look at several possible expansions to the computer to add an RS-232-C serial port and some more memory and then begin with a study of programming. ■

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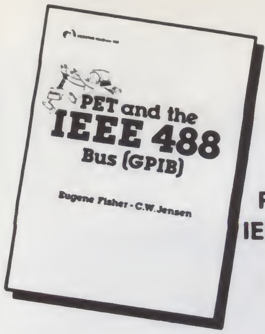

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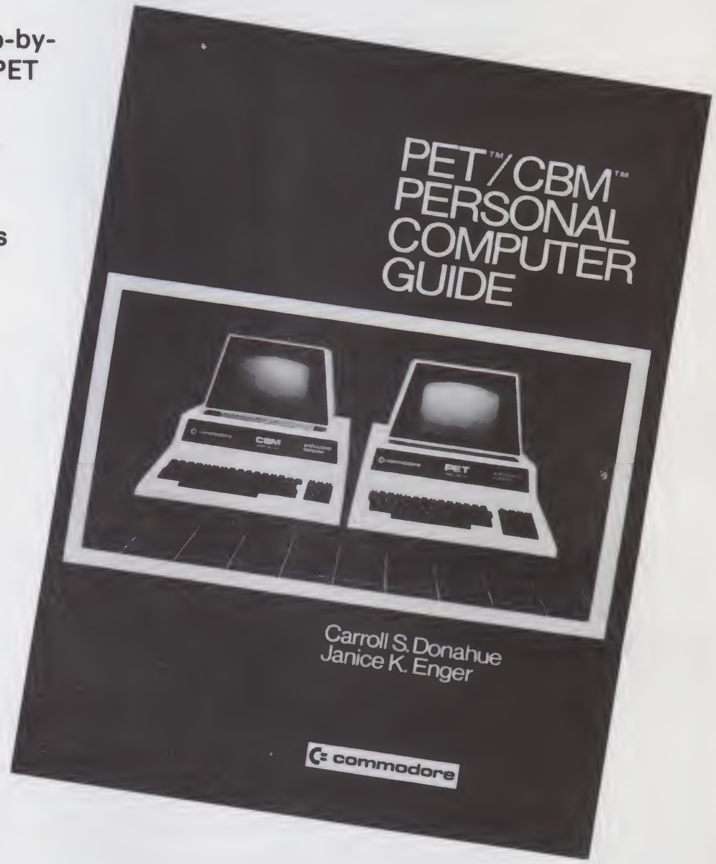

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1110

Programming for Profits

Even if they don't know it yet, many small businesses need you and your ideas.

Jon Kapecki
161 Crosman Terrace
Rochester, NY 14620

If you think you need a degree in accounting to write a business program or that all the useful ones have been written, read on. The man who invented the electric corn popper fulfilled a need that people didn't even know they had. Hundreds of innovative ways to exploit the microcomputer in small-business situations still exist.

Furthermore, since most people in small business wouldn't use a system full time for conventional business computing, such "bonus" programs can provide them with an additional incentive for investing in a computer.

You can approach your local computer store about offering small businesses a package deal. The shop provides the hardware, and perhaps the accounting software, from what's commercially available, while you provide the specialty software—all at one package price. You get a good marketing outlet, and the dealer gets an inexpensive carrot to help him sell more equipment.

Further income is possible from advertising the software to similar businesses, through the pages of this magazine and the trade journals.

Ideas to Program By

Start with this experiment. Pick up a copy of your local Yellow Pages and thumb through the categories. In each case, try to think how a computer could either help bring in more business or decrease unit costs (remember, that's what you're selling, not a computer program!). Write down whatever ideas come to mind, no matter how silly or extravagant they may sound.

When you have a list of 30 or so, stop and evaluate them. Is the use cost-effective? Does the computer offer advantages over how it's done now (if it's done now)? Will it bring new customers into the store or encourage repeat patronage? Can the idea be extended with modification to other businesses? Do you have (or can you get) the expertise necessary to implement the idea?

Put the ideas that survive this first screening away for a week or so. When you look at them again, ask the same questions. Then talk over your best ideas with someone in the business. Ask them whether they would like a system with that sort of capability and, if not, why not. Don't let them discourage you (new ideas take some getting used to), but do take their criticisms seriously.

Finally, realize that in the beginning, these ideas probably won't return your time investment in dollars. View the projects as part of a self-supporting hobby. Then you

```
-----Can I Help You Find Something?--------

Just type in the name of the item you're looking for

        and press the BLUE key. (If you make a mistake,

        press the RED key and start again).

MOUSE TRAPS

You'll find MOUSETRAPS in HOUSEWARES on Aisle 16.

-----Can I Help You Find Something?--------

Just type in the name of the item you're looking for

        and press the BLUE key. (If you make a mistake,

        press the RED key and start again).

BULBS

You'll find LIGHT BULBS in LIGHTING on Aisle 12.

You'll find PLANT BULBS in the GARDEN SHOP, east entrance.
```

Example 1. Typical dialogue of a Store Directory program.

can be pleasantly surprised when some of them start to pay off.

The following ideas generated by the algorithm given above have each been discussed with at least one businessperson in the field, modified if necessary, and pronounced a good idea. None, to my knowledge, has yet been offered commercially. Use them as springboards for your own ideas. That's where the real money lies.

Store Directory. Ever walk into a place like Big Bob's Bargain Barn looking for mousetraps? Sure, there's a posted store directory that'll tell you where housewares or hardware is located. But which stocks mousetraps? Then, once you get the right department, try to find them. Worse yet, try to find a clerk to help you find them.

You get the picture. Many larger stores—supermarkets, department stores, discount houses, hardwares, lawn and garden centers, lumber and building suppliers—stock thousands of different items, but have only general store directories. A computerized store index can supplement the directory to help the customer find specific items.

Sell the store management on how such a system can cut down on the cost of extra personnel, relieve customer frustration, improve the accuracy of customer assistance and—most important—increase sales (they can't buy what they can't find).

Depending on the size of the store and stock, the system could range from a simple PET or TRS-80 with floppy to a multi-terminal system time-shared to a computer such as the Cromemco running multi-user BASIC.

Your software will have to be literally fool-proof (see Example 1 for a typical dialog). This probably means a hardware or software write-protect for the disk, as well as a software disable for the usual return-to-monitor code. The program will be continuously in the run state with a special keyword (perhaps with embedded control characters) to allow authorized personnel to gain control of the monitor.

You'll also have to develop an easy-to-use file update system (redundant files are a must) for the store personnel to use. Maybe this is the time to learn about hash-coding schemes if there isn't a good commercial package for you to adapt.

Some more elaborate software features might include attempts to decode spelling errors (redundant entries or a software scheme?) for the best match (even the basic system should ignore plurals and embedded blanks), an end-of-day recall for the most frequent non-hits (is the item just poorly indexed or should the store be stocking it?) and even an automatic notification for store personnel when a customer needs more help.

```
Dear Mr. Kapecki:

        Grub control season is almost here, and now's the time to make an
appointment for that important phase of lawn care. Based on your needs last
year, complete grub control services this season will  cost you only $45.
(Of course if your lawn area has changed since last year, we'll be happy
to quote a new price.)

        Fall is also an important time for nourishing your lawn for the
long winter season ahead. We can provide a fall fertilizer feed at the same
time as grub control for just $15 extra.

        To set up your appointment, just give us a call at 442-3202.
                                                   Valley Garden Services
                                                   Rathmor, New York
```

Example 2. Sample lawn-care notice.

Bars. In this case, a computer's novelty is its sole justification, but this is the kind of business where that's justification enough. Bars install all sorts of gimmicks to attract customers away from other bars. You can offer a gizmo that will do the same, and the books as well.

You'll need a system that will handle color graphics. An Apple does nicely. When the customer orders a drink, he or the bartender keys in the order. The screen responds with the drink recipe while running an animation of a drink being mixed and poured. If the requested drink is not in the computer's repertoire (and this is part of the gimmick—people love to stump computers), the customer can teach the computer the recipe, and it will be stored for future orders.

Between orders the screen can display a kaleidoscope pattern or play computer games, or even offer one of those ever-popular bar quizzes (the beat-the-computer motif again).

Periodic Services. Many businesses and professions could profitably send customized periodic reminders to their customers. Dentists and veterinarians are obvious, but what about insurance agents? Home valuation changes each year as a function of inflation and location. A personalized reminder every year or two could include the customer's old and new home valuation and the incremental amounts necessary to bring the policy up to current coverage.

Services for lawn care, furnaces and cooling systems, cars, small engines and office machines all involve periodic work, and reminders based on the customers' particular needs or desires or model to be serviced can be customized.

For instance, the frequency and type of furnace maintenance depend on furnace type and its age. Likewise, lawn services are related to the customer's preferences and location (in some areas everybody needs fall grub control, while spring insecticide and crab grass defoliation are optional).

The type of equipment needed here depends on the complexity of the service, the size of the customer list and the degree of personal character the notice must reflect. For instance, a homeowner might be pleased simply to get a computer-generated postcard reminding him of a particular lawn or furnace service he requires. A line printer with sprocket feed and forms control would do nicely. Example 2 shows a typical notice with a plea for further business.

An office equipment house or insurance firm, on the other hand, might want more personalized letters, requiring a Selectric or Diablo printer and the ability to inter*leave* special paragraphs.

The most profitable way to write a system of this sort is to keep it as modular and general as possible and easily adaptable to different businesses. You'll want to be able to key in both the date of purchase (or service) and the type of equipment or property. If the customers' demands become complicated, you may find it profitable to build your program around one of the commercially available data-base management systems or word-processing systems (remember, however, that unless you work out a deal with the program owner, a single purchase of commercial software usually implies use in a single installation, no matter how you have enhanced the software).

Garden Shops. On every nice day you see people streaming in and out of Ed's Lawn and Garden Center with sacks of fertilizer, grass seed, herbicide, crabgrass killer and

grub destroyer. But how many sacks do they need? Sell them too few and the store loses money (they don't come back, a store owner told me; they spread it thinner). Sell them too much and the customer gripes, and is left with hazardous poisons in the garage.

Enter the trusty computer with an answer to the problem. The store clerk ushers the customer over to a video screen covered with a faint grid. After keying in the maximum property dimensions, he helps the customer sketch out the property on the now-scaled grid. Using a light pen, the areas occupied by house, driveway, walks, garden and so on can all be sketched in. When the customer is done, the clerk keys in the products of interest, and the computer responds with the number of bags of each product needed.

The next time the customer comes by, the clerk needs only enter the street address (owners change and move, but addresses don't) and the products needed, and the computer calculates the suggested purchase.

Refinements could include a condition code, a simple packed integer associated with each address that includes a few simple descriptors relating to soil type or last activity.

Such a service can generate customer loyalty and repeat business no discounter can match.

It also offers an advertising novelty. It can also be built around a relatively inexpensive system. A PET or TRS-80 with floppy will do nicely if the customer list is small or if the store owner is willing to swap disks that could be conveniently labeled by area.

Diet Clubs. As Americans grow at the waistline, so grow the number of diet clubs dedicated to stripping them of that excess bulk. In addition to the national franchises, you'll find that local gyms, health clubs, high school extensions and the Y are getting into the business. There's gold in those hills of fat—and for you, too.

Here's where the computer fits in. The would-be dieter tells the staff adviser his current weight, height and build. The computer suggests a weight goal and a timetable. After this is OKed by the customer, he and the staffer go over a list of foods for likes and dislikes, special dietary needs and life-style requirements.

The computer then chugs out two weeks or so of suggested menus that meet the dieter's needs and preferences, along with any special recipes necessary to prepare them. In the following weeks, goals are evaluated, changes made in preferences ("I really don't *like* broccoli that well"), and a new diet plan generated. After the goal is achieved, the computer can print out some sample menus for aiding weight maintenance.

Perhaps you're not a dietician. But the beauty is that you don't need to be. Fortunately, more learned heads than ours have worked out the requirements, and in a form suitable for computer adaptation.

The system is called, among other fancy names, an exchange or substitution diet, and is the basis—admitted or not—of most diet group plans. It involves creating daily menus by selecting an appropriate number of items (depending on the total calorie intake desired) from each of several lists. The result is a menu that is appropriately low in calories, but adequate in nutrition. (Any program you write should always include the advice that anyone beginning a diet should check with a physician and continue the plan under professional supervision.)

Rating the Diets by Theodore Berland (Beekman House/Signet) contains a good collection of various exchange lists along with the original references. The extent and imagination of the substitution lists is the main difference between various exchange diets, and you can raid all of them for ideas.

Depending on the amount of record-keeping and on-line recipe storage your client requires, this project could be a job for a relatively small system. The menu creation program and a good-sized food list should fit in a 16K to 32K stand-alone computer. More elaborate systems, of course, could profitably use a disk.

You can ease programming and save space by assigning to each menu entry an integer code containing the list number (which food list it is in), an item number (within the particular list), preference/use code and compatibility flag (see Example 3). The latter makes sure that you don't serve meat loaf at breakfast or puffed rice cereal at dinner. Certain meals will always include some specified items. The rest of the time, you'll want the program to randomly cycle through the lists as it creates the menus, skipping those items that have already been used and those that are flagged for "dislike."

Since you'll probably exhaust at least one list before finishing a full menu period, you'll have to make arrangements to recycle. Some experimentation with the menus produced will suggest other uses for the unused code bits.

Job Scheduling. I'll confess I didn't come up with this one by scanning the Yellow Pages. I wasn't even aware of the problem; it came walking in the front door.

A prominent heating contractor in town was bemoaning the problems involved in scheduling his nine servicemen. "Bill, my top man, can do everything. Frank doesn't know heat pumps, but he's good on the old stuff. Al, now he's the best we've got on big air-conditioning systems, but he won't

Reader Service index—page 241

```
A suggested code for menu items:

                              3 5 7 2 6
              item #                      compatibility flag
                                             e.g., 0=breakfast item only
              list #                                1=dinner only
                                                    2=ok for box lunch
                                                                  etc.



                        preference/use code
                             0=dislike
                             1=like (converts to 3 on use)
                             2=prefer (converts to 1 on use)
                             3=already used this cycle
                                         etc.
```

Example 3. Assigning integer code to menu entries.

touch the old boilers. Then, of course, the guys rotate who's going to be on evening and weekend shifts. It's enough to drive our dispatcher crazy!"

That's not all, I learned. He has a small crew of lower-level technicians who are limited only to furnace cleaning, for which a lower rate is charged. Furthermore, his firm serves the whole city and a dozen surrounding suburbs. Excess travel time is lost money, so it's in his best interests to assign jobs that are close together to the same guy—if the guy can handle them.

It was a job for a good scheduling algorithm, and I told him so. He was intrigued enough to say that he would talk to his son-in-law, a programmer, about it all (the firm already has a computer for billing and payroll).

All this is a variant on critical path programming, the same kind of techniques large partitioned computers use to schedule efficient job flows on large projects. The literature on the subject is filled with useful techniques already coded.

Could other similar businesses use this same sort of package? Why not?

And what about taxi companies?

More Software Projects

There you have them—an even half-dozen ideas. But is that all? Not by a long shot. What about a pharmacy record system that remembers what drugs a client is taking and flags potential incompatibilities? (The challenge here is to fit it in a system that a pharmacy could afford.) Or an inventory control system for rent-all stores that records what items are out or in and future reservations and computes the bill (less the deposit) when the item is returned?

How about a records management system for clinical labs (there are over a dozen in our town alone) to produce a schedule for running tests, a record of the results and a report and bill to send to the requesting physician? What about a smart time-of-day, day-of-week traffic counter built around a low-power, battery-operated single-board computer?

I haven't checked all of those out, or a dozen others I could list. But it's your turn. You can come up with an equal number of good, or even better, software projects that can bring in good money—ones that probably no one else has considered.

All you've got to do is the one thing your computer can't do—imagine! ■

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CP/M for Single-Drive Systems

The CP/M operating system was not intended for use on computers with only one disk drive. The Filecopy program makes it easier.

Ken Barbier
Borrego Engineering
PO Box 1253
Borrego Springs, CA 92004

Since the CP/M operating system from Digital Research was intended for an expensive microprocessor development system, its creator didn't anticipate the problems that some of us low-budget users encounter. Digital Research doesn't even seem to want to recognize the existence of mini-floppy disk drives and obviously never intended the system to be used in single-drive environments.

But CP/M is available for such mini-based systems as North Star, Micropolis and TRS-80, since it has been adapted to these formats by vendors who are licensed by Digital Research to make such adaptations. And some of these personal computer systems run CP/M on a single disk drive.

This can lead to complications and inconveniences. But mini-floppies themselves are convenient, and the price is certainly right. The major problem is in transferring your programs from one disk to another to provide the safety of a backup copy.

I wrote Filecopy to overcome this problem. Since it takes up only 1K of disk space, the cost is low.

The addition of the Filecopy program makes CP/M a practical operating system for a computer equipped with only a single mini-floppy disk drive. But the frequent disk swapping necessary means you should have your disk drive within easy reach of your work station.

Filecopy Features

This program will let you copy any type of CP/M file from one disk (the read disk) to another (the write disk) in a few seconds with little fuss. It can even help recover files with read checksum errors, which most systems software will not accept.

Of course, Filecopy can't correct data errors, but you can tell the program to ignore read checksum errors, and the output file will have the checksum correct, permitting later manual patching of the data errors.

Filecopy's console messages have no

```
A>FILECOPY STUFF.BAS

SINGLE DRIVE FILECOPY  V80.1   11 FEB 80

READ DISC IN DRIVE. THEN CR

FILE DOES NOT EXIST! BACK TO CP/M?

A>FILECOPY DUMP.COM

SINGLE DRIVE FILECOPY  V80.1   11 FEB 80

READ DISC IN DRIVE. THEN CR

WRITE DISC IN DRIVE. THEN CR

FILE ALREADY EXISTS. ENTER:  X TO ABORT
                             CR TO ERASE IT

ALL DONE! BACK TO CP/M?

A>
```

Example 1. Console messages displayed during a typical Filecopy operation. The first file named did not exist on the input disk, so the operator was given a chance to swap disks before the program reloaded the CP/M operating system. The second file requested for copying, DUMP.COM, was found on the input disk and loaded into memory. When the output disk directory was checked, it was found to contain a file with the same name. The operator is given the option of updating this existing DUMP.COM file or returning to CP/M.

mysterious codes. Any errors encountered are spelled out clearly, as shown in the sample console messages in Example 1.

The program listing includes pauses at strategic points to let you change disks at leisure and correct read, write or operator errors in simple fashion. For example, you can load Filecopy from one disk, and it will prompt you for the disk from which you want to read a file. If the read file is on a different disk, you place it in the drive and hit the carriage-return key (CR). When the read file has been loaded into memory, the program prompts for the write disk and waits for another CR.

At any of these pauses, you can abort the entire operation and reload CP/M by typing X instead of CR. The same is true following error messages. Recoverable errors are displayed, and you can choose to correct the error, ignore it or reload the system. In the case of nonrecoverable errors, either the CR or X will reload CP/M, since there is no valid option in this case.

Operating Filecopy

Since the purpose of the program is to copy one file from a read disk to a write disk, there are few options available and virtually nothing to learn. As in Example 1, you call for the program by name and include the file name and file type that you want to copy.

In the first example, I want to make a backup copy of the BASIC language file named STUFF. Filecopy is loaded, displays the sign-on message and asks me to place the disk with the source file on it into the drive. Usually this is the disk already in the drive, so I type a carriage return on the console (this action is obviously invisible on the printout).

The program searches the disk file directory for STUFF.BAS, and in this example cannot find it. A pause following "BACK TO CP/M?" allows me to change the disk in the drive if I want, before going through the *CP/M reload*.

Now I remember that it was DUMP.COM that I wanted to copy, so I once again call for the copy program, giving the file name on the same line. This time, Filecopy finds the file and loads it into memory and then pauses after asking for the output disk to be placed in the drive. Following the CR, the program searches this disk directory and discovers that it already has a file by that name.

If I'm totally confused by this, I can type X to reload the system and then display the directory to get things sorted out. But in this example I know that I want to replace an old version of DUMP with a new update, so I type CR. Filecopy will now erase the old file and write the new file on the disk. Following this is another pause to let me insert my original disk, or any other, before the exit back to CP/M.

That's all there is to using the program. I made no attempt to incorporate exotic features such as changing the file name between read and write or making multiple copies. I kept it simple and small, so that it only takes up 1K of disk space, the minimum possible under CP/M.

The program will most often be used to make a quick backup of a file following a long edit session. And when your program has been fully debugged, Filecopy is the quickest way to move the resulting .COM file to other disks.

The first thing you will probably want to do with Filecopy is use it to place a copy of Filecopy.COM on each of your disks.

Program Notes

I won't try a detailed discussion of the

Program listing. Filecopy program in assembly language.

```
                *************************************************************
                *                                                           *
                *      SINGLE DRIVE  FILECOPY  V80.1  11 FEB 80             *
                *                                                           *
                *    WILL COPY FILES UP TO (11 K BYTES + BIAS) IN LENGTH    *
                *  ALL CONSOLE AND DISC I/O IS THROUGH BDOS CALL AT  LOC 5  *
                *                                                           *
                *************************************************************

                *  CP/M BDOS ADDRESSES

0000 =          RBOOT   EQU     0               ; RE-BOOT CP/M
0005 =          BDOS    EQU     5               ; BDOS CALL ENTRY
005C =          FCB     EQU     5CH             ; DEFAULT FILE CONTROL BLOCK
0080 =          INBUF   EQU     80H             ; DEFAULT DMA ADDRESS

                *  CP/M BDOS FUNCTIONS

0001 =          READF   EQU      1              ; READ CONSOLE INTO (A)
0002 =          TYPEF   EQU      2              ; WRITE CONSOLE FROM (E)
000D =          INIT    EQU     13              ; INITIALIZE DISC IN DRIVE A:
000F =          OPEN    EQU     15              ; OPEN FILE
0010 =          CLOS    EQU     16              ; CLOSE FILE
0011 =          FIND    EQU     17              ; FIND FILE IN DIRECTORY
0013 =          DELE    EQU     19              ; DELETE FILE
0014 =          READ    EQU     20              ; READ FILE
0015 =          WRIT    EQU     21              ; WRITE FILE
0016 =          MAKE    EQU     22              ; CREATE FILE DIRECTORY ENTRY

0100                    ORG     0100H           ; TPA PROGRAM START ADDRESS

0100 C33402             JMP     START           ; GO TO PROGRAM START

                *  CONSOLE I/O THROUGH BDOS CALL

0103 E5         CI      PUSH    H               ; SAVE REGISTERS
0104 D5                 PUSH    D
0105 C5                 PUSH    B
0106 0E01               MVI     C.READF         ; READ FUNCTION
0108 CD0500             CALL    BDOS            ; RETURN CHAR IN (A)
010B C1                 POP     B               ; RESTORE OTHER REGISTERS
010C D1                 POP     D
010D E1                 POP     H
010E C9                 RET

010F E5         CO      PUSH    H
0110 D5                 PUSH    D
0111 C5                 PUSH    B
0112 5F                 MOV     E.A             ; MOVE PRINT CHAR TO (E)
0113 0E02               MVI     C.TYPEF
0115 CD0500             CALL    BDOS
0118 C1                 POP     B
0119 D1                 POP     D
011A E1                 POP     H
011B C9                 RET
011C 3E0D       CCRLF   MVI     A.0DH           ; CR LF TO CONSOLE
011E CD0F01             CALL    CO
0121 3E0A               MVI     A.0AH
0123 C30F01             JMP     CO

0126 E1         MSGXP   POP     H               ; OUTPUT MESSAGE AND RETURN
0127 7E         MSGX1   MOV     A.M             ;  THROUGH INDEX (H.L)
0128 FE00               CPI     0               ; TEXT TERMINATOR = 0
012A CA3401             JZ      MSGEX
012D CD0F01             CALL    CO
0130 23                 INX     H
0131 C32701             JMP     MSGX1
0134 23         MSGEX   INX     H               ; POINT TO TEXT + 1
0135 E9                 PCHL                    ; AND RETURN THERE

                * FILECOPY CONSOLE MESSAGE SUBROUTINES

0136 CD1C01     RDMSG   CALL    CCRLF           ; PROMPT FOR READ DISC
0139 CD2601             CALL    MSGXP
013C 5245414420         DB      'READ DISC IN DRIVE. THEN CR '
0158 00                 DB      0
0159 CD0301     RDMS1   CALL    CI              ; GET RESPONSE
015C FE58               CPI     'X'             ; ALLOW EXIT
015E CA0000             JZ      RBOOT           ; BACK TO CP/M
0161 FE0D               CPI     0DH             ; ACCEPT CR ONLY
```

program here, since the listing is heavily annotated, and assembly-language programmers will find it completely straightforward. I assume you have some familiarity with the internal workings of CP/M for the following optional discussion. Readers only interested in using the program can skip the rest of the text and start typing.

All console and disk I/O is passed through the single BDOS entry point accessed through the jump instruction at location 5. Filecopy exits through the reload vector placed in location 0 by CP/M. The program uses the standard file control block and sector buffer defined by CP/M. It is otherwise totally self-contained and requires that no changes be used with any version of CP/M.

Since the copy operation is done in one pass, there is a size limitation on the files that can be copied. Data will be loaded into memory from the BUFFR starting at 0487H up to just below CP/M's BDOS, overlaying the CCP, as does PIP.

In a minimum 16K byte version of CP/M, the file size is limited to over 11K bytes. This should prove no inconvenience to the user of a 16K system, since the only file that big you will probably ever generate is a print file, which is not normally ever copied or backed up. ■


```
0163 C25901             JNZ     RDMS1
0166 CD1C01             CALL    CCRLF           ; ACKNOWLEDGE
0169 C9                 RET                     ; AND RETURN

016A CD1C01     WRMSG   CALL    CCRLF           ; PROMPT FOR WRITE DISC
016D CD2601             CALL    MSGXP
0170 5752495445         DB      'WRITE DISC IN DRIVE. THEN CR '
018D 00                 DB      0
018E CD0301     WRMS1   CALL    CI
0191 FE58               CPI     'X'
0193 CA0000             JZ      RBOOT
0196 FE0D               CPI     0DH
0198 C28E01             JNZ     WRMS1
019B CD1C01             CALL    CCRLF
019E C9                 RET

019F CD1C01     RDERR   CALL    CCRLF           ; SHOW READ ERROR
01A2 CD2601             CALL    MSGXP
01A5 5245414420         DB      'READ ERROR!  ENTER X TO ABORT '
01C3 0D0A               DB      0DH,0AH
01C5 2020202020         DB      '                  CR TO IGNORE '
01E5 00                 DB      0
01E6 CD0301     RDER1   CALL    CI              ; ACCEPT CR OR X
01E9 FE58               CPI     'X'
01EB CA1202             JZ      EXIT
01EE FE0D               CPI     0DH
01F0 C8                 RZ                      ; RETURN MEANS IGNORE
01F1 C3E601             JMP     RDER1           ;  READ ERROR

01F4 CD1C01     WRERR   CALL    CCRLF           ; SHOW WRITE ERROR
01F7 CD2601             CALL    MSGXP
01FA 5045524D41         DB      'PERMANENT WRITE ERROR! '
0211 00                 DB      0
0212 CD2601     EXIT    CALL    MSGXP
0215 4241434B20         DB      'BACK TO CP/M? '
0223 00                 DB      0
0224 CD0301     WRER1   CALL    CI              ; WAIT FOR CR OR X
0227 FE0D               CPI     0DH
0229 CA0000             JZ      RBOOT
022C FE58               CPI     'X'
022E CA0000             JZ      RBOOT
0231 C22402             JNZ     WRER1           ; AS ONLY LEGAL RESPONSE

                * BEGIN FILECOPY PROGRAM

0234 CD1C01     START   CALL    CCRLF           ; SIGN ON MESSAGE
0237 CD2601             CALL    MSGXP
023A 53494E474C         DB      'SINGLE DRIVE FILECOPY  V80.1  11 FEB 80'
0261 0D0A               DB      0DH,0AH
0263 00                 DB      0
0264 CD3601             CALL    RDMSG           ; PROMT FOR READ DISC
0267 115C00             LXI     D,FCB           ; LOOK FOR FILE
026A 0E11               MVI     C,FIND          ; BEFORE GOING AHEAD
026C CD0500             CALL    BDOS
026F FEFF               CPI     255             ; DOES FILE EXIST?
0271 C29302             JNZ     RUN             ; YES. READ IT
0274 CD1C01             CALL    CCRLF           ; NO. GIVE UP
0277 CD2601             CALL    MSGXP
027A 46494C4520         DB      'FILE DOES NOT EXIST! '
028F 00                 DB      0
0290 C31202             JMP     EXIT            ; REBOOT CP/M

0293 215C00     RUN     LXI     H,FCB           ; SET UP FCB'S FOR
0296 114504             LXI     D,RFCB          ; READ AND WRITE
0299 0E10               MVI     C,16
029B 7E         RUN1    MOV     A,M
029C 12                 STAX    D
029D 23                 INX     H
029E 13                 INX     D
029F 0D                 DCR     C
02A0 C29B02             JNZ     RUN1
02A3 215C00             LXI     H,FCB
02A6 116604             LXI     D,WFCB
02A9 0E10               MVI     C,16
02AB 7E         RUN2    MOV     A,M
02AC 12                 STAX    D
02AD 23                 INX     H
02AE 13                 INX     D
02AF 0D                 DCR     C
02B0 C2AB02             JNZ     RUN2
02B3 218704             LXI     H,BUFFR         ; INITIALIZE POINTER
02B6 224204             SHLD    HSAVE           ;  INTO BUFFER
02B9 AF                 XRA     A               ; ZERO RECORD COUNTS
02BA 324404             STA     ASAVE
02BD 326504             STA     RFCBN
02C0 328604             STA     WFCBN

                * READ THE FILE INTO RAM

02C3 114504     RFILE   LXI     D,RFCB          ; USE READ FCB
02C6 0E0F               MVI     C,OPEN          ;  AND OPEN THE FILE
02C8 CD0500             CALL    BDOS
02CB FEFF               CPI     255             ; ERROR?
02CD C2EF02             JNZ     RFIL1
02D0 CD1C01             CALL    CCRLF
02D3 CD2601             CALL    MSGXP           ; YES. SHOW IT
02D6 554E41424C         DB      'UNABLE TO OPEN FILE! '
02EB 00                 DB      0
02EC C31202             JMP     EXIT            ; AND ABORT
02EF 114504     RFIL1   LXI     D,RFCB          ; READ A RECORD
02F2 0E14               MVI     C,READ
02F4 CD0500             CALL    BDOS
02F7 FE00               CPI     0               ; GOOD READ?
```

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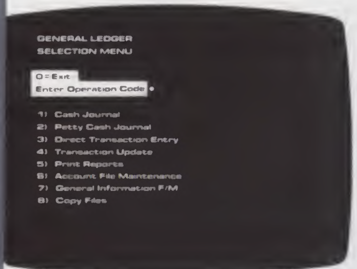

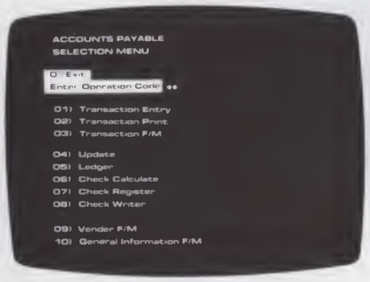

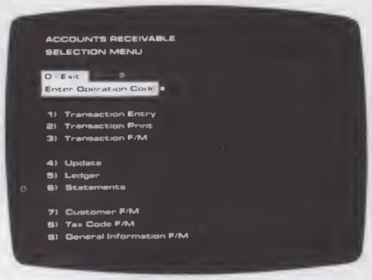

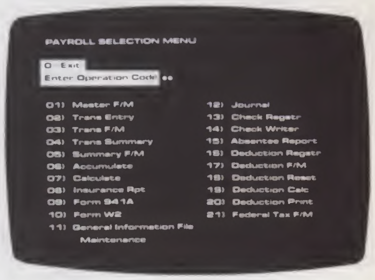

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```
02F9 CA0403                 JZ      RFIL2             ;  YES. STORE IT
02FC FE01                   CPI     1                 ; OR END OF FILE?
02FE CA4103                 JZ      WFILE             ;  YES. WRITE IT
0301 CD9F01                 CALL    RDERR             ; NO. SHOW ERROR
0304 2A4204        RFIL2    LHLD    HSAVE             ; STORE THE RECORD
0307 118000                 LXI     D.INBUF
030A 0E80                   MVI     C.80H
030C 1A            RFIL3    LDAX    D
030D 77                     MOV     M.A
030E 23                     INX     H
030F 13                     INX     D
0310 0D                     DCR     C
0311 C20C03                 JNZ     RFIL3
0314 224204                 SHLD    HSAVE             ; AND NEXT ADDRESS
0317 3A4404                 LDA     ASAVE             ; COUNT THE RECORD
031A 3C                     INR     A
031B 324404                 STA     ASAVE
031E 3A0700                 LDA     7                 ; ANY MEMORY LEFT?
0321 3D                     DCR     A
0322 BC                     CMP     H
0323 C2EF02                 JNZ     RFIL1             ; YES. KEEP READING
0326 CD1C01                 CALL    CCRLF             ; NO. ABORT
0329 CD2601                 CALL    MSGXP
032C 46494C4520             DB      'FILE IS TOO BIG! '
033D 00                     DB      0
033E C31202                 JMP     EXIT

                   * WRITE THE FILE ONTO DISC

0341 CD6A01        WFILE    CALL    WRMSG             ; PROMPT FOR WRITE DISC
0344 0E0D                   MVI     C.INIT            ; INITIALIZE DISC FOR WRITE
0346 CD0500                 CALL    BDOS
0349 116604                 LXI     D.WFCB            ; SEE IF FILE EXITS
034C 0E11                   MVI     C.FIND
034E CD0500                 CALL    BDOS              ; WE CAN'T WRITE TWO!
0351 FEFF                   CPI     255
0353 CAC703                 JZ      WFIL1             ; NO. CONTINUE
0356 CD1C01                 CALL    CCRLF
0359 CD2601                 CALL    MSGXP             ; YES. ERASE OR ABORT?
035C 46494C4520             DB      'FILE ALREADY EXISTS. ENTER:  X TO ABORT'
0383 0D0A                   DB      0DH.0AH
0385 2020202020             DB      '                               CR TO ERASE IT '
03B1 00                     DB      0
03B2 CD0301        WAIT1    CALL    CI
03B5 FE58                   CPI     'X'
03B7 CA0000                 JZ      RBOOT
03BA FE0D                   CPI     0DH
03BC C2B203                 JNZ     WAIT1
03BF 116604                 LXI     D.WFCB            ; ERASE THE OLD FILE
03C2 0E13                   MVI     C.DELE
03C4 CD0500                 CALL    BDOS
03C7 116604        WFIL1    LXI     D.WFCB            ; OPEN FILE FOR WRITE
03CA 0E16                   MVI     C.MAKE
03CC CD0500                 CALL    BDOS
03CF FEFF                   CPI     255               ; OPEN OK?
03D1 C2F603                 JNZ     WFIL2             ; YES. CONTINUE
03D4 CD1C01                 CALL    CCRLF
03D7 CD2601                 CALL    MSGXP             ; SHOW UNABLE TO OPEN
03DA 4F5554204F             DB      'OUT OF DIRECTORY SPACE!
03F2 00                     DB      0
03F3 C31202                 JMP     EXIT
03F6 218704        WFIL2    LXI     H.BUFFR           ; INITIALIZE POINTER
03F9 224204                 SHLD    HSAVE
03FC 2A4204        WFIL3    LHLD    HSAVE             ; MOVE RECORD TO OUTPUT
03FF 118000                 LXI     D.INBUF           ;  BUFFER (SAME AS INPUT)
0402 0E80                   MVI     C.80H
0404 7E            WFIL4    MOV     A.M
0405 12                     STAX    D
0406 23                     INX     H
0407 13                     INX     D
0408 0D                     DCR     C
0409 C20404                 JNZ     WFIL4
040C 224204                 SHLD    HSAVE             ; SAVE NEXT ADDRESS
040F 116604                 LXI     D.WFCB            ; WRITE THE RECORD
0412 0E15                   MVI     C.WRIT
0414 CD0500                 CALL    BDOS
0417 FE00                   CPI     0
0419 C4F401                 CNZ     WRERR             ; SHOW WRITE ERROR
041C 3A4404                 LDA     ASAVE             ; COUNT RECORD WRITTEN
041F 3D                     DCR     A
0420 324404                 STA     ASAVE
0423 C2FC03                 JNZ     WFIL3             ; AND WRITE ANOTHER
0426 116604                 LXI     D.WFCB            ; DONE. CLOSE THE FILE
0429 0E10                   MVI     C.CLOS
042B CD0500                 CALL    BDOS
042E CD1C01                 CALL    CCRLF
0431 CD2601                 CALL    MSGXP             ; PROMPT FOR RE-BOOT
0434 414C4C2044             DB      'ALL DONE! '
043E 00                     DB      0
043F C31202                 JMP     EXIT              ; AND WE ARE ALL DONE!


                   * RAM BUFFERS

0442               HSAVE    DS      2                 ; BUFFER ADDRESS STORE
0444               ASAVE    DS      1                 ; RECORD COUNT
0445               RFCB     DS      33                ; READ FILE CONTROL BLOCK
0466               WFCB     DS      33                ; WRITE FILE CONTROL BLOCK
0487 00            BUFFR    DB      0                 ; DATA BUFFER START

0465 =             RFCBN    EQU     RFCB+32           ; RECORD COUNTS. READ
0486 =             WFCBN    EQU     WFCB+32           ; AND WRITE
```

Moonshine, Dixie And the Atari 800

Frank J. Derfler, Jr.
PO Box 691
Herndon, VA 22070

Mr. Wayne Green
Publisher, Microcomputing
Peterborough, NH 03458

Dear Wayne,

I am still working on the review of the Atari 800, but I've run into a little problem. I will need at least $999.99 for the article. I know this is a little above the price per page you generally pay, but I have had some unusual expenses. You told me to "give it the full treatment," and I did.

I went to the Logic Store in Montgomery, AL, to pick up a computer. They agreed to loan me one for evaluation because they have several in stock and delivery of more is no problem. We bundled up their demonstrator, and I tried to pick it up to walk out.

That machine is a fooler! It looks deceptively like a video game machine, but underneath that pretty cover beats the heart of a tank. Phil "popped the hood" on the thing to reveal the strongest and tightest chassis I have seen since Raquel Welch. It weighs about ten pounds. The power supply is one of the ubiquitous wall-plug transformers, but those things do work and save chassis space and heat. The large amount of engineering and design in the physical part of the system is evident. No wonder the Atari 800 had no problem passing the FCC's new rf radiation standard tests.

Finally, with a little more respect for the Atari, I got the system home and set up in my well-equipped (two soldering irons and a digital probe) basement computer laboratory. In the old days, when I used to test radio equipment, I would just plug the stuff in and read the manual days later. Computers are different though. You can plug a computer in and the darn thing will just sit there and look at you until you feed it some magic code. So I sat down to read the manuals.

I tell you, Wayne, the Atari manuals show the way manuals should be done: pictures, step-by-step directions, high-quality paper and some real meat for the folks who want to learn more about programming. They give you a clear operator's manual, a thick programmed text on BASIC programming and a cassette called "Invitation to Programming." They are really trying to cover ground from the raw novice to experienced computer user.

But, as an old electron chaser, I thought they should have included some information on hardware. Atari isn't meant for the guy who wants to fool around with the insides of a computer. There isn't a schematic or theory of operation to be seen. You can program it, but don't try to look inside.

I had just plugged the power supply into the wall when there was a thumping on the door and my neighbor, nemesis and self-taught genius inventor, Vic Interrupt, fumbled down the stairs. Cradled in each arm were several mason jars full of something Vic calls Old Megabyte. Old Megabyte is a by-product of Vic's gasahol production and much better used for fueling 18-wheelers than people. Vic's condition showed he had been "testing the octane rating" a bit already.

"Say, I saw you bring in some new gear and thought I'd come over and see what it is," Vic said. As he spoke, he twisted the top off a mason jar and handed it to me. I knew better than to refuse. I took one sip of the stuff and resolved to pour the rest down my gas tank later.

"Atari? Isn't that just a video game machine?" he asked. The fumes from Old Megabyte were making my head spin, so I took another sip in self-defense.

"No," I coughed and sputtered, "this is a very powerful computer with a 6502B CPU. It comes with 8K of RAM and 10K of ROM operating system in the standard version. Cost's right at a thousand bucks with the cassette deck and all."

I opened the first lid on the machine and showed Vic two packages the size of a deck of playing cards.

"These are additional ROM cartridges. The one on the left has BASIC, and the one on the right is a pre-packaged Atari program. There is an assembly-language cartridge that can go in the left slot, and they advertise a PILOT language ROM pack, too. Now, look at this."

I took off the second lid and waved in the direction of some larger slots that looked like an over-sized four-slice toaster.

"These are for RAM cartridges. They come in either 8K or 16K, and the system can take up to 48K of RAM plus all that ROM. They get about $250 for the 16K module. That's a reasonable price for added memory."

"What kind of program cartridges do they have?" Vic wheezed.

"Atari games, as you would expect, but they also have given a lot of attention to education and household management. The cartridges simply give an alternative to tape or disk. You still save programs on tape and read them back in that way too."

"What do the little buggers cost?" Vic asked. He had a cartridge in his paw and looked like he was going to take a bite out of it.

"They run from $40 to $70 a piece," I said, grabbing the cartridge back. "It is convenient for the user, but a bit expensive. There is a little trade-off. If you just use the programs they sell on these ROM cartridges you can get away with having less RAM. I guess it is also a great way to foil software bandits."

Vic peered at the Atari tape deck. "That looks like a special deck just for the system."

The Atari 800 with 8K of RAM and 10K of ROM.

"Yes, it is very easy to use and loads glitch free at 600 bits per second. One nice, neat cable and no grounds or relays to worry about. An audio track can be loaded on a tape, along with the digital track. This capability allows you to both run programs and listen to voice or music through the television speaker. The tape recorder motor is under software control, so you can record instructions or comments on the tape to play at the appropriate spot in the program in response to the user's answers or keyboard actions. Great potential for education."

"Make it do something," Vic said, waving his mason jar. Some Old Megabyte spilled on the rug, and I could have sworn there was a puff of smoke. I took another sip to steady my nerves. The darn stuff was so volatile it was evaporating from the jar.

"OK. Drag the color TV over here and we'll hook it up."

The Atari attaches to your TV like a video game. You screw a switch box to the antenna terminals to set it up. The entire setup took less than a minute. My screwdriver was a little clumsy, but I got the screws tight with Vic's encouragement.

I connected the video cable to the switch box, turned the Atari on, and we were rewarded with "READY" on the top of the screen.

We had a ball playing with the keyboard. The keyboard has an excellent "feel." It is smooth and firm. The cursor is fully controllable, and Vic and I practiced drawing circles on the screen with it. This feature allows full screen editing. You don't have to fool around with Edit commands. If you want to change a program line, you just fly the cursor there and change it. The reset key is well-protected from clumsy fingers. The graphics figures are available right from the keyboard, too.

Lowercase capability and reverse video are standard. We filled the screen with printing and found we could get 24 lines, 40 characters wide. This is obviously a compromise over the use of a color monitor, but the flexibility of the system and the density of the graphics made it very nice to use.

I picked up the book and read, "Graphics resolution, 320 X 192. Sixteen colors provided with eight intensities. Four independent sound synthesizers playing four octaves with programmable volume through an internal speaker."

"It sings," Vic observed with a broad smile.

"Almost," I replied.

We loaded the demonstration tape I had gotten with the unit. It loaded smoothly, but it did not display the program lines going in as some systems do. After I typed RUN, the screen lit up with beautiful color graphics, and the internal tone generators did a pretty good job with the William Tell Overture. Vic smiled and drooled just a bit.

The small package on the left contains BASIC or other program languages. The small right-hand slot is for program cartridges. The larger modules in the rear are for RAM expansion. Note the heavy cast aluminum chassis.

After it calmed down, the screen instructed me to insert a different cassette into the tape deck and hit the play button. I did that, hit return as I was instructed to do, and a voice came out of the TV speaker. This method of making the computer talk is a tremendous complement to the video display and adds another dimension to the capability of a microcomputer system without tying up great chunks of RAM. Atari has a "Talk and Teach" education program library that should be effective.

"Have they got disks and other widgets to hang off of it?" Vic asked as he opened another mason jar for me. Mine had evaporated a few minutes ago.

"Oh, yeah. They have an interface module that comes with four RS-232 ports and a parallel Centronics printer port. Game paddles plug in right here in the front of the computer, but they don't come with it. They have a mini-floppy disk system that gets about 92K on a disk. Of course, you can use a modem with one of the RS-232 ports off the interface module.

"The 800 comes up in a 'video typewriter' mode automatically, so it should make a great terminal for use with electronic bulletin boards or with computer utilities such as MicroNet or The Source. It should be a natural for word processing, too. I haven't seen any smart terminal or word-processing software yet, but the disk comes with a file management system. Some pretty smart entrepreneur could come up with good programs pretty quickly."

Vic brightened at that last phrase.

"Speaking of entrepreneurs, maybe you and this little beauty can help me. You know, right now when we make gasahol we only mix alcohol with gasoline about one to ten. If we could beef up the alcohol carbon chain, we could use a lot more alcohol in the mix and a lot less gasoline."

Vic scribbled some diagrams on the back of an envelope and proceeded to tell me more than I wanted to know about petroleum engineering. What he said made sense, though. In a way it was just a problem in geometry. You simply had to go through a huge number of trials before you found the molecular chain that would do exactly the right job. At least, that is the way I remember it now. It is a little hazy, but I think I understood it at the time.

We began to piece together a program that would continue to vary the geometry of the alcohol molecules so that the proportion of alcohol in gasahol could be raised to as much as 50 percent. The Atari BASIC programs are just like Microsoft BASIC, so we had a lot of standard routines we could put together. We had a lot of fits and starts, but somewhere after midnight we got a program that ran.

While Vic was out refilling the mason jars, I added a little subroutine that played "Dixie" on the Atari's audio generators, when a tentative solution was

displayed. It was somewhere around 2 AM when a solution hit. The Atari flashed a formula on the screen and started the first few bars of the song.

Well, before it hit "land of cotton," Vic was standing on his feet singing with his hat in the air. He started leading the band with his left hand, but the liquid sloshed out of the jar, and a large portion gushed into the cooling slots of the Atari. The screen blinked and presented three formulas in quick succession. They were labeled: "50%, 60% and 75% Alcohol Formulas *Confirmed Solution*"

Then the screen went blank and the Atari started to smoke.

It died at about "old times there are not forgotten" and fell into a low sizzle. All that beautiful engineering may be rf proof, but it was never meant to stand up to a flash of inspiration provided by Old Megabyte. Vic and I were so surprised that neither of us could remember much of the formulas on the screen. The program died in RAM.

So, that's it, Wayne. I have to pay the computer store back for the computer. Then I have to buy another one. Vic has a special high-octane brew ready, and we are going to try to recreate the entire scene...as well as we remember it. This time, we are going to set up a video tape machine to tape the screen, and we will catch the formulas before they fade away. It will be tough on the Atari, but it will be tougher on OPEC if we can get the 75 percent solution. I only need $1999.98 for the two computers.

Do you think you could see your way clear for a cut in the profits?

Sincerely,

Derf

Derf

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Mortgage with Prepayment—Use this program to develop a prepayment plan that will provide optimum savings on the cost of the mortgage, reduce the terms of the mortgage and help avoid overtaxing your income in the process. It will calculate the cost of the original mortgage, as well as the cost and savings on a mortgage with annual prepayments. If you must borrow money to make the prepayments, the computer takes the added interest into consideration.

Financier—This program is designed to take the extensive paperwork out of your daily financial planning. It performs ten common financial calculations that can help you: (1) design optimum investment schedules; (2) check on depreciation rates, amounts and resale values; and (3) let you know exactly what a given loan is going to cost in terms of time and money.

Minimum system requirements are an Apple II or Apple II Plus with 32K of memory, one mini-disk drive and Applesoft BASIC.

Order No. 0162AD $19.95

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PROGRAMS IN GERMAN:

The programs listed here can be purchased through:
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Markstrasse 3,
7778 Markdorf, West Germany

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6074P	Arcade I
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PROGRAMS IN ITALIAN:

The programs listed here can be purchased through:
HOMIC s.r.l.
Piazza De Angeli 1,
20146 Milano, Italy

TRS-80*

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9107R	Guerre Stellari
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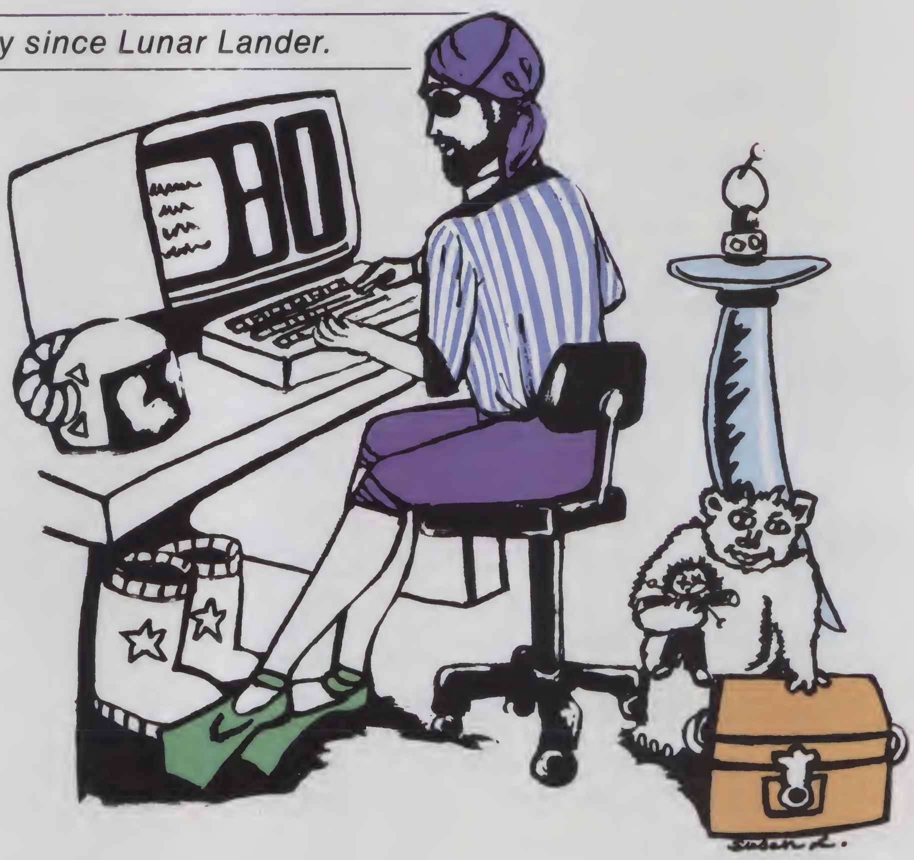
Role-Playing Games Reviewed

We've come a long way since Lunar Lander.



William L. Colsher
4328 Nutmeg Lane, Apt. 111
Lisle, IL 60532

Role-playing games are only now maturing. Game situations are more complex than before, and machine-dependent features are becoming increasingly advanced. The days of screen displays that look like they were designed on a Teletype are finally behind us.

Adventure and Temple of Apshai are typical of what is now available. Their manufacturers—Adventure International and Automated Simulations, respectively—dominate the field of producing role-playing games. The games are worth critical comparison and evaluation.

But first some historical background might be helpful.

Computer Games History

Lunar Lander was perhaps the earliest role-playing game to become popular among computerists. The object was simple: Land a simulated vehicle on the surface of the moon or some planet. Elementary physics resolves any situation that can arise; the game loses its appeal as soon as the player realizes there is a clear-cut way to win.

Hammurabi, a simple simulation of the economics of an ancient city, was more challenging. The player balanced several variables, such as population, immigration, harvest and how much to spend on new land. The game included several possible goals, and judicious use of the random number generator introduced the sort of uncertainty an ancient ruler might have known.

As players became better programmers and the home computer introduced programming to a wider audience, role-playing games became more complex. Eventually, the programmers discovered the fantasy games, which had been popular in science-fiction fandom for many years. These games were based on the exploits of heroes, thieves and mythical beings as they sought wealth and power in strange worlds.

The gamers felt it was impossible to produce a computer version of their games. They weren't aware of what a good programmer could do.

In the mid-70s, a game called Adventure began to appear on large mainframes, initially DEC 10s. The game was based on Dungeons and Dragons, one of the most popular fantasy games. It was immense; I have a copy of the PL/1 source of a version written in 1977 that is 95 pages long.

Moria, a similar but more complex multi-player game, appeared on the PLATO

system. Moria had magnificent graphics. With a number of players, all at different terminals, the game took on a kind of creepy reality—you wandered through a city searching for treasure while constantly on the watch for others who would murder you for what you had found.

Personal computers slowly matured, and eventually versions of these games began to appear. At first, they were available only for large disk-based systems. Programmers had tried to duplicate the gigantic Adventure that existed on the mainframes. Others developed small versions, usually in BASIC, that included only a few of the features of the big versions.

Adventure

Adventure is not one game, but rather a generic title for a series of similarly structured games from Adventure International (Table 1). They are $14.95 apiece and are available for 16K TRS-80s, Sorcerers, and 24K PETs and Apples. Disk versions are available at a higher cost.

Because these games must fit into a small computer, they have a sort of "bony" feel. Messages are short, and since they must run on a number of systems, no graphics are used. I appreciate Al's desire to provide games that run on lots of computers, but I also feel that a program should use as many features of the computer it runs on as possible.

Unlike the original Adventure, Al's games include a wide variety of play environments. The original concept of wandering through caves and woods expanded to include a pirate adventure, a voodoo castle, a mission impossible and even an outer space adventure. The author, Scott Adams, has since extended the concept pretty well to its limit.

These games come with essentially no documentation or instructions. A single 8½ × 11 inch sheet contains a reprint of a magazine review and a few low-level hints to help the novice get going. Other than that, there's nothing to do but load the program and begin. Half the game involves figuring out how to get the computer to do what you want it to.

Eight different adventures are now available from AI. Strangely, the lower-numbered ones are somewhat better than the more recent ones. I have tapes 1 and 6,

1	Adventureland
2	Pirates Adventure
3	Mission Impossible Adventure
4	Voodoo Castle
5	The Count
6	Strange Odyssey
7	Mystery Funhouse
8	Pyramid of Doom

All tapes are $14.95 each with a 15 percent discount for an order of three or more. Versions are available for disk at extra cost. Numbers 1 and 2 are recommended for the novice. Order from:

Adventure International
Box 3436
Longwood, FL 32705
(305) 862-6917

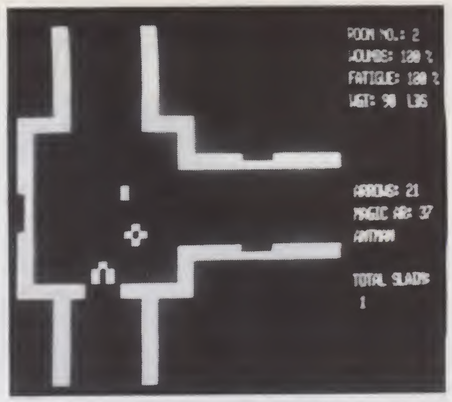
Table 1. Adventure International products.

Name	Available for	Price
Starfleet Orion	PET, TRS-80, Apple II	$19.95
Invasion Orion	PET, TRS-80	$19.95
Temple of Apshai	PET, TRS-80	$24.95
Taipan	TRS-80	$ 9.95
Tanktics	PET	$14.95
TREK-78	TRS-80	$ 9.95

All TRS-80 versions require 16K Level II. Apple II requires 16K or 32K. PET versions vary. Order from:

Automated Simulations
PO Box 4232
Mountain View, CA 94040

Table 2. Automated Simulations products.



Screen display of one of over 230 rooms to explore in the Temple of Apshai. The rectangular shape represents the treasure, the cross shape is a monster, and the other shape is the adventurer. The current status of the adventurer is shown to the right of the display.

Adventureland and Strange Odyssey. Adventureland seems to have many more treasures and situations to figure out than Strange Odyssey. In addition, Strange Odyssey has essentially no help information for the novice.

Interestingly, these games are basically nonviolent. The most violent acts I've encountered are blowing up a brick wall and blowing up a rock; virtually no killing is involved.

Temple of Apshai

Temple of Apshai is one of several games available from Automated Simulations. It costs $24.95 and is available for 32K PETs, 16K TRS-80s and 48K Apple IIs. A TRSDOS version is available for the same price. (Table 2 contains other games from AS.)

Temple is based on the old-fashioned role-playing games, particularly Dungeons and Dragons. In fact, the excellent documentation includes instructions for converting characters you have used in other games to Temple characters. You can even use a table of exchange rates to convert money!

Unlike the Adams Adventures, Temple has many graphics. Unfortunately, it isn't as easy to use. Two main programs written in BASIC each take about four minutes to load. Data files take another two minutes or so. A program called Innkeeper sets up the game for you, creating a character if you don't already have one. You also purchase supplies for your journey from the Innkeeper.

Finally, it reads the data file for the level of play you select. Levels range from 1, which is quite easy, to 4, which is reasonably difficult for the experienced player. Additional levels have recently been announced. Naturally, the higher levels

contain better treasures but more formidable monsters.

The second main program, Dunjonmaster, controls your journey through the Temple. It keeps track of what you have found and makes things interesting with real-time monsters.

Unlike Adventure, Temple is quite violent. You hack and slash and shoot your way through crowds of monsters to get the treasure and escape with your life. Good graphics show the outline of the room you're in and the monsters moving toward you.

The documentation supplied with Temple is nothing short of excellent. I have never seen game documentation like this. A 56-page book describes the game environment and contains a good discussion of role-playing games in general. This massive amount of documentation could intimidate the beginner, but, in fact, the hardest part of the game is waiting for the programs to load. Automated Simulations provides a quick reference card covering all the commands.

Conclusions

Hunting buried treasure and fighting off deadly monsters are admittedly a lot of fun. But much more could be done. The educational possibilities are immense. How does a child learn but by playing the roles assigned him by adults?

A home-economics game could teach about shopping for nutritious foods to keep the family happy and healthy. A business program could teach about the factors that go into a successful small business. Why not a game in which a family on a budget takes a driving trip? Balancing such factors as interesting spots, the cost of gasoline and the cost of food and lodging can be a real challenge, as any harried father knows. What if someone gets sick? What do you feed the dog, or do you leave him home? These are just a few ideas that could keep a programmer busy for a couple of years. ■

The Great SWTP CPU Switcheroo

A flip of a switch sets up your MP-B motherboard for either 6800 or 6809 operation.

Phil Hughes
P.O. Box 2847
Olympia, WA 98507

When I received my MP-69 (6809) processor board from Southwest Technical Products, I was (and still am) at a point where I wanted to play with the 6809 but still needed to run my 6800 processor board for my computer work. I expect that most people who have a 6800 and plan to convert to the 6809 will be in the same boat.

The instructions supplied by SWTP to modify the MP-B motherboard so that you can use the MP-09 processor board consist of ten steps. I wanted to be able to switch back and forth between the MP-A2 and MP-09 boards with a minimum of aggravation. After analyzing the changes proposed by SWTP and testing one that didn't work, I came up with the following solution.

The changes affect four areas. First, the MP-B motherboard doesn't decode address bit A12. This must be added, but the change will allow both the 6800 and 6809 to still operate properly. Second, the user-defined lined UD1 and UD2 are used by the 6809. As long as you are not using them with your 6800, this change will not affect operation of the 6800. Third, the 6809 expects the I/O ports to be located at address E000 hexadecimal, and the 6800 expects them to be at 8000 hexadecimal. A switch must be installed to support the two modes.

Finally, the 6809 uses the M.RST (manual reset) line on the bus for a purpose other than the reset button. I chose to leave the current reset button connected to the M.RST line so that it could be used with the 6800 CPU; I added a separate SPST normally open push-open switch to serve as the 6809 reset button.

By implementing the 6800-to-6809 conversion in this way, you only have to throw one SPDT switch and exchange processor boards to switch from the 6800 to the 6809. I have been using this method of reconfiguration for two months and have found it very acceptable.

Conversion Steps

Fig. 1 shows the modified circuitry on the motherboard. The following steps replace the directions on page 12 of SWTP's MP-09 assembly instructions. Note that switch should be located as close as possible to the IC area of the motherboard. I used an SPDT slide switch and soldered one tab to the ground foil of the motherboard.

1. Cut the foil conductor connecting pin 10 to pin 12 of IC4 (7400 NAND gate) on the bottom side of the motherboard. (Not shown on MP-B schematic.)
2. Attach and solder an insulated jumper between pin 11 of IC4 and pin 6 of IC6 (74LS138) decoder) on the bottom side of the board.
3. Attach and solder a separate insulated jumper between pin 12 of IC3 and address line A 12 on the bottom side of the board. (This completes decoding of A12.)
4. Cut the PC trace connecting IC6, pin 11, on the bottom side of the board. Cut the trace at IC6.
5. Run a wire from IC6, pin 11, to one side of a SPDT switch.
6. Run a wire from IC5, pin 12, to the common terminal of the new switch.
7. Run a wire from IC6, pin 7, to the remaining side of the new switch.
8. Tape the three jumper wires to the board so they don't break or get pinched.
9. Cut the two wires from the UD1 and UD2 lines on the motherboard and also the other end of these wires from the 12-pin Molex connector.
10. Reinstall the motherboard and reconnect the connector going to the MP-P power supply board. ■

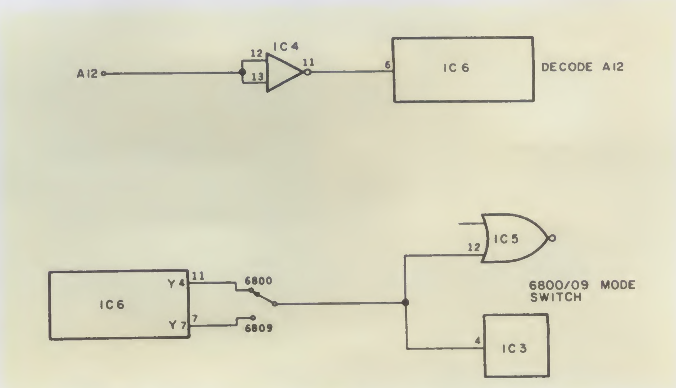


Fig. 1. Modifying the circuitry on the motherboard.

The Robotype 2001, An Unusual Typewriter Interface

Maximize your typewriter's output and give your secretary a break.

Donald W. Drury
4681 E Granville Rd.
Westerville, OH 43081

How would you like to have your office typewriter double as a printer for your microcomputer?

Compu-Matics, Inc., has developed a unit that will convert any electric typewriter with a standard American keyboard layout. The unit, called the Robotype 2001, sits over the keyboard, and a matrix arrangement of control plungers strikes the typewriter keys.

The Robotype requires no modification of the typewriter. The self-contained unit needs no external power supply or special software. It is well-constructed, portable (24 pounds), can be set up in less than one minute and can be easily removed to let you use the typewriter for other purposes.

The component interfaces with the computer through a standard Centronics parallel port. With an optional serial interface, it can also be plug-to-plug-compatible with Teletype, 20 mA current loop, TTL or RS-232C terminals (with or without modem control). The Robotype costs less than $1000.

Photo 1. Top view of Robotype mechanism showing the push bars and sliding plates (top center), the four push-bar solenoids (two on each side) and the solenoids driver board with the 13 small solenoids (lower center). The small solenoids are mounted directly on the board beneath the black metal plate, which also acts as a heat sink.

Design

The Robotype was designed to avoid the bulk and expense of a separate solenoid and its associated circuit for each key. It has a matrix of sliding plates and push bars. Thirteen small solenoids activate the sliding plates, and six heavy-duty ones operate the four push bars, space bar and shift key.

Compu-Matics designed a base on which you mount your typewriter and attach the Robotype. This maintains a constant distance between the plungers and the typewriter keys. Predrilled base plates are available for Selectric I and II, Remington SR 101, Adler 1000, Royal 5000, Olympia and Smith-Corona typewriters. Others can be custom-fitted.

The ac power frequency synchronizes the control unit with the typewriter. The Robotype runs slightly behind the typewriter so that the typewriter runs well without losing characters. At the maximum typewriter speed the Robotype will always have the typewriter clutch engaged to minimize clutch wear and make the output as fast as possible.

Typewriters with a mechanical keyboard memory presented a design problem. If a key is depressed with the typewriter off, it will print when the typewriter is turned on. But the Robotype takes advantage of this and uses it to compensate for the slight variations in cycle time for different characters. You therefore get the maximum output from the typewriter.

Compu-Matics also had to figure out how to time and interlock other nonprinting functions such as carriage return, back space, space forward and tabs. In addition, the Robotype had to be able to simulate dead keys that print an auxiliary character (such as the diacritical mark) but can't be

allowed to advance the carriage. This must all be done automatically and with minimal delay time.

Some systems use software to provide set delay times, either through no ops in machine language or nulls in higher-level languages. The time required will vary. The delays, therefore, have to be set for the maximum possible time. This reduces the output capacity of the unit.

Robotype's designers used hardware. A small microphone mounted inside the typewriter case detects the noise made by the carriage as it completes its movement. The unit uses audio and logic processing to discriminate between the general noise and the desired signal.

All controls associated with this circuitry are preset, and you need do nothing but put the pickup in its location and plug it into the unit. Thus, all functions associated with carriage movement are entirely automatic.

Photo 2. Robotype 2001 installed on mounting board with IBM Selectric II typewriter.

Description

The unit is sturdy. The large solenoids on each side of the unit (Photo 1) are mounted on the main support bracket of the unit. The cooling fins nearby give extra cooling protection in extreme situations, such as when one character is printed repeatedly at maximum speed. These and special Teflon cushions at the base of each solenoid help minimize wear and increase reliability.

The power supply is well designed. The main ac power line is protected by a 2 amp in-line fuse. Also, each supply line to the three solenoid driver circuits has a separate fuse, and the power supply board itself has several self-protecting regulators. Damage from power surges or circuit failure would be unusual.

The power drain of the basic unit is about 25 watts. The power supply provides a maximum of about 100 watts. Compu-Matics over-designed it to handle all possible expansion boards without difficulty.

Several optional plug-in boards will extend the unit's capabilities considerably. A serial interface and a 256-byte buffer can be used with a modem for printout of remote information. Both the serial interface and the buffer have independent handshakes at input and output.

You can get 1K, 2K and 4K memory boards for additional buffer memory. With the larger memory boards and a CRT display, you can assemble a page at a time and dump it to the Robotype.

You can also get a small microcomputer for simple programming with BASIC. This, along with an optional keyboard, makes the Robotype a stand-alone microcomputer with about 4K of ROM and 2K of RAM for programming.

The company is also developing an interface board to let you save a data file on cassette tape.

The Robotype adjusts to operate successfully with a variety of computer systems and typewriters. It handles this simply with two sets of DIP switches on the main board.

One set controls the character output rate to the typewriter. This lets you match the output rate of the Robotype to the typewriter you will be using.

For example, the IBM Selectric II has a maximum printing rate of 15 characters per second, while the Smith-Corona has a maximum rate of ten characters per second. The Robotype can adjust by turning one switch off and another on in a few seconds.

A second set of switches configures the Robotype to receive the computer signals with the proper logic. This sets either positive or negative logic individually for strobe, data lines, acknowledge and ready. One switch on this pad selects the ROM for the typewriter.

At present the two general types of preprogrammed keyboard configuration are the IBM Selectric and the Adler.

If you need special configurations, you can send Compu-Matics the appropriate keyboard mapping specifications; they'll set up a ROM and send it with the unit.

A maximum of 16 diacritical marks and eight other special keys can be mapped. This limitation is dictated by the number of available ASCII codes not already in use.

The unit is reliable and easy to repair. Compu-Matics uses modular circuit boards for quick replacement and for pinpointing defective boards easily.

If you have enough units to warrant inhouse maintenance, a test unit is available. Defective boards can either be repaired in the field or returned for repair. Any returns will be repaired and sent out within 24 hours of receipt.

The Robotype comes with a standard 90-day warranty on parts and labor. Once out of warranty, most repairs (usually a board) are done at the factory for a nominal charge. The company also offers complete inspection and reconditioning of the entire unit. Inspection or repair can be done for no more than $60.

Since the unit is new, no data are available on failure rates in the field. Compu-Matics hopes to keep this minimal with strict quality control. The prototype was tested for over a year in its present form before being introduced. Several units were put on a test run for 150 continuous hours without failing. Each new unit is run continuously for 24 hours before being shipped.

Evaluation

The unit I received had been in use for some time as a demonstrator. When I got it home and set it up I had difficulty in getting clean copy. In some places, two characters would print in the same space.

I also had trouble with the carriage return and line feed. Sometimes the unit would line feed without a carriage return. At other times it would do neither.

I called the designer, who suggested that perhaps the plunger height adjustment was a little off. He advised me to lower the rear of the plunger deck to deepen the thrust on the carriage return key. I tried this, but to no avail. I called him back to suggest that I meet with him with my unit, the typewriter I was using and my computer to pinpoint the exact causes of the problems I was experiencing.

As it turned out, there were two separate problems. The over-printing of characters was caused by the typewriter being slightly out of adjustment and dirty. This slowed the

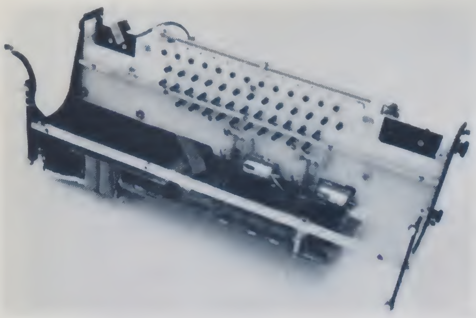


Photo 3. Underside of Robotype showing space bar solenoid (center) and shift solenoid (to the right). The board shown in the lower center is the main logic board.

typewriter mechanism, and it was unable to keep up with the computer. Two chips on the main board were also malfunctioning and causing the problems with the line feed and carriage return. I found this problem and corrected it in about an hour.

I tried the unit the next day at home and again had line-feed problems. I found that the key plunger adjustment at the front end of the unit had become misadjusted during transport when the retaining knobs loosened. I tightened the front retaining knobs and cured the problem for good.

I was impressed with the company's dedication to the idea that every user have a properly functioning system. They want and expect feedback from their customers about what is happening in the field. If difficulties arise, they try to help the customer determine the source of his problems, as they did with me.

The user instructions have an excellent technical section for those who wish to configure the unit for use with a particular system. General setup instructions, however, were buried in the mass of technical detail.

At the time of this writing, a revised user's manual is in preparation and will include user setup instructions as a separate section.

Photo 4. Installation of microphone for detection of completion of carriage return in IBM Selectric II.

Any word-processing program that provides printout capabilities can be used. The sales agent for the unit uses the Mr. Memory package with his Apple II. I used one of my own programs with my TRS-80 Model II.

Software Compatibility

Software compatibility is generally good. Only a few special features may require modification of existing software.

The Robotype does not recognize a line feed unless it is preceded by a printable character. This will require that any LPRINTs for vertical spacing be followed by a blank if, as in my operating system, they are output to the printer as a code 12 (0C hex).

The form-feed character is programmed in the Robotype to execute a carriage return. Therefore, if you want automatic form feed within the program, you'll have to include a special routine. I wrote a four-line subroutine for this function for the program I used.

The other obvious option is to include a pause in program operation at the end of each page and manually reposition the paper before proceeding.

The bell function sounds a buzzer on the Robotype to indicate a form feed.

Because typewriters can set manual tabs, this function can be sped up by including a special TAB program function.

Printing

Printing time averaged about three minutes per page, including the form-feed spacing. I printed 12 pages of text in about 35 minutes. It's not as fast as a dot matrix printer or the more expensive letter-quality printers.

The unit runs well even under adverse power conditions. It is rated to function normally with input power variations of plus or minus ten percent. My unit continued to function normally from under 100 volts up to 130 volts. I saw no change in the output of the unit and no apparent ill effects to the electronics. If you encounter power problems, they would affect the computer and the typewriter more than the Robotype.

When he reviewed the article, the designer told me that these voltage limits were actually used during the quality-control tests.

Once I ironed out the initial problems with my unit, the major problem I had was keeping the paper straight in the typewriter. For those whose main use would be form letters or other documents that can be completed in a page or two, this presents little problem. In my case, where I was preparing a 15 to 20 page manuscript, ordinary pin-feed computer paper was not heavy enough to be gripped reliably.

After a bit of investigation, I found that 20-pound plain white paper was available in continuous feed forms for slightly more than the ordinary paper. This heavier paper has less tendency to slip, as long as it is fed freely into the typewriter.

Comparison with Other Units

Most Selectric-based ASCII terminals have a chassis almost identical to the ordinary Selectric typewriter. The main differences are a heavier center bearing, pinion gears and clutch assembly. Some have a slightly more powerful drive motor. Older model terminals use cam-actuated contacts to drive the print mechanism, while the newer ones use magnetic reed switches as actuators.

Almost all, except the newer electronic typewriters, require external power supplies, and most require special software drivers for compatibility with the microcomputer.

The main drawback for the person who is not a hobbyist and wants a system that works without tinkering is maintenance. Most used terminals are long out of warranty. If they are modified to work with a particular computer, the manufacturer may not want to maintain them, or may do so at exhorbitant rates.

Since you don't have to modify the typewriter, its standard warranties and maintenance agreements stay valid.

Conclusion

The Robotype is a hardware- and software-compatible interface between any microcomputer and most electric office typewriters. To my knowledge, no other unit can make this claim.

Once the initial adjustments have been made, the unit can be set up and ready for use in less than one minute. The maximum output, limited by the capability of the typewriter, can match speeds from seven and a half to 15 characters per second. Average printing time is about three to five minutes per page.

Most word-processing software should be able to control the Robotype with minimal modification. The only changes necessary with my system involved the way in which the Robotype interacts with the TRS-80 Model II system software in processing printer control characters.

For the business or professional man wanting an economical way to use the computer for quality printing of letters and forms, the Robotype seems ideal.

For more information about the unit, contact Applied Computer Systems, Inc., PO Box 111, 431 West Broad St., Pataskala, OH 43062.■

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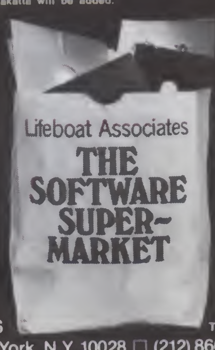

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The Secret Life

Of the 8085

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Borrego Springs, CA 92004

Different folks have different methods for specifying how many instructions a computer will execute. You hear statements such as, "The 8080 executes only 76 instructions, but 'Brand X' includes 144 different op codes."

I don't know and couldn't care how these evaluations are made. But if you look at a numerical list of 8080 op codes, you will find that of the 256 possible combinations of eight bits, only 12 op codes are unused (Table 1). Each of the remaining 224-bit patterns is decoded and executed in the 8080, with second and third byte fetches used only for data or address information. To me, this means that the 8080 has a 244 instruction set.

When Intel introduced the 8085, they still left ten unused codes. But they added two operations not included in the 8080: the op codes 20 and 30 (all op code references are in hex). These control the 8085's expanded hardware interrupts and read and write through the serial I/O port. These operations are detailed by Intel in the MSC-85

Op codes not in 8080	New* Mnemonics	Function
08	DSUB B	Subtract (B,C) from (H,L)
10	RHR	Rotate (H,L) right through carry.
18	RDL	Rotate (D,E) left through carry.
20	RIM*	Read interrupt mask and serial data in.
28 xx	DMOV D,H	(H,L) plus immediate byte xx into (D,E).
30	SIM*	Set interrupt mask and serial data out.
38 xx	DMOV D,SP	(SP) plus immediate byte xx into (D,E).
CB	RSTV	Restart at 0040 if V flag = 1.
D9	SHLX	Store (H,L) at memory location (D,E).
DD yy xx	JND	Jump to location xxyy if D flag = 0.
ED	LHLX	Load (H,L) from memory location (D,E).
FD yy xx	JD	Jump to location xxyy if flag = 1.

*Existing "legal" 8085 instructions (see reference 2).

Table 1. Intel 8085 instructions including the "secret" op codes.

System reference manual.

The publication does not give the effects of executing the remaining ten op codes not used in the original 8080, though they were obviously planned. The reason for not mentioning them in the company literature is obscure. But they are there, and we can take advantage of them.

The 16-Bit Accumulator

As is true for the 8080, the 8085 uses the A register as an accumulator for 8-bit operations. In the 8080 family the H L register pair constitutes a 16-bit accumulator. All of the original 16-bit arithmetic operations leave their results in the HL register: the double precision add instructions DAD B, DAD D, DAD H and DAD SP. The 8085's secret op codes add a double-precision subtraction operation. For consistency I will call this instruction DSUB B, since a 16-bit subtraction of the contents of the BC register pair from the contents of the HL register pair leaves the remainder in the HL register.

Arithmetic operations are not complete without a carry flag. The 8080's original carry flag, bit 0 of the flag register (Fig. 1), is set if an 8-bit addition results in a number greater than 255 (decimal, or FF in hex), the maximum contents of the accumulator.

For example, if the content of the A register is FF (hex) and you add 1, the result is 0 in the accumulator, and the carry flag is set, telling you that 255 plus 1 is not zero. This same flag is used to indicate a borrow if you subtract a larger number from a smaller. For example, if the accumulator contains 1 and you subtract 2, the result is FF in the A register, and the carry flag (now actually a borrow flag) is set.

The 8080 didn't include a carry/borrow flag for 16-bit operations, although this same flag does act as a carry for some of the 8080's double-precision operations. To avoid confusion with the single-precision carry/borrow flag, the 8085 includes a new flag, which I will call the D flag, for "double-precision carry/borrow." This new flag is bit 5 of the flag register; it was previously unused.

This D flag can be tested to reveal the results of any 16-bit arithmetic operation, including the original 8080 INX and DCX instructions. In the 8080, you could use the instruction INX to relocate the BC, DE or HL register pairs past FFFF, or use the DCX to relocate them past 0000, and never know it. In the '85, the D flag will be set if either of these operations occurs.

The INX and DCX simply add or subtract 1 from the designated register pair. The new D flag will now record any carry or borrow that may result from executing an INX or DCX of these 16-bit registers.

Testing the D Flag

Two new jump instructions are incorporated in the '85 to test the D flag. An op code of FD, followed by the usual 16-bit address field, will cause a jump to the specified address if the D flag is set. Execution will continue with the next instruction if the D flag is not set, as is the usual case with conditional jumps. This instruction, JD, stands for "jump on D flag."

A complementary instruction, JND (jump on no D flag), has an op code of DD. Since Intel chose not to document these operations, I have chosen mnemonics to most closely match the existing op code mnemonics.

Shifts and Rotates and Confusion

Every experienced assembly-language programmer I have ever talked with who encountered Intel's mnemonics RLC, RRC, RAL and RAR agrees that somebody blundered. To us, RLC implies "rotate left through carry." This is not so in Intel's world. They insist that RAL means "rotate left through carry," and that RLC means "rotate left without carry." I have always suspected that this was the result of a typographical error and was never admitted, or corrected, by the guilty party. Too late now; we are stuck with it.

In any case, the 8080 includes four instructions that cause single-precision rotates of the accumulator, right or left, through the carry or not.

Since room is left, the 8085's secret instructions include two new double-precision rotates. I earlier decided that the HL register pair is the double-precision accumulator, so these operations should both operate on the contents of HL. Right? Wrong.

Executing an opcode of 10 will cause the contents of HL to be shifted one bit to the right, with the rightmost bit being shifted into the carry. But not the new double-precision carry, the D flag. The shift is into the old carry, the flag bit 0. So, what gets shifted into the most significant bit of the HL pair? The contents of the old carry? No. Nothing! It remains unchanged.

This instruction is probably more trouble to learn than it is worth, but for the sake of completeness we have to call it something. So to be consistent with Intel's inconsistency, I will call it RHR, for "rotate HL right through carry."

A real 16-bit rotate is included in the new ops, though. Executing 18 will cause the DE register pair to rotate left through the old carry, flag bit 0. The previous contents of the carry are now shifted into the low-order bit of DE, as should be the case. This one works. Why wasn't the HL pair used? Why not the double-precision carry? I'll call this

Flag Register Bit	7	6	5	4	3	2	1	0
Flag	S	Z	D	A	X	P	V	C

S Sign Bit
Z Zero Flag
D Double Precision Carry
A Aux Carry
X Unused
P Parity
V Double-Precision Overflow
C Carry

Fig. 1. The 8085 Flag register, including the two "secret" flags.

one RDL, as Intel would have, for "rotate DE left through carry."

These RHR and RDL mnemonics are consistent with Intel's RAR and RAL for the A register. Now all of them are wrong.

Some New Moves

Zilog calls register-to-register transfers "load," but Intel originally specified that a load involves memory as the data source, and *the R-to-R* operations are moves. I prefer Intel's moves, but the two new moves included in the 8085 are bewildering.

The first, op code 28 (followed by one byte of immediate data), places the contents of HL into the DE register pair and adds the immediate byte into the result in DE. This amounts to copying the contents of an index and adding the immediate value to it as an offset, without disturbing the original index. This could be convenient for table lookup, but, it would be more useful if the offset was the contents of another register, rather than an unchangeable immediate value.

As it is, this instruction is useful only if you know how far ahead in a table you want to look and never want to change that displacement in a particular code sequence. This is OK for quick looks into a particular, known place in a table, but wouldn't be usable inside a search loop, since the displacement is a constant. You can write self-modifying code, but if you do, don't talk to me.

We could call this one DMOV D,H, for "double-precision move D register from H register," remaining consistent with the usual sequence "destination, source."

And how about this next one: 38 xx will cause DE to be loaded with the contents of the stack pointer, plus the immediate byte xx. Now we have something. As data is pushed onto the stack, the stack pointer, SP, is decremented by two for each PUSH, subroutine CALL, RSTart or hardware interrupt. If we need to know what was pushed onto the stack 1, 2,. . . n number of pushes back, we can use this instruction to put the stack pointer, incremented by 2 times n, into DE. Then, executing an LDAX D will put the contents of that point on the stack into the accumulator, where we can look at it. If we are in a subroutine or interrupt service routine, this sequence could be used to look back to see which main program location called us. I like this one. Color it DMOV D,SP.

Indexed Load and Store

The '80 family includes instructions to permit the contents of the 8-bit accumulator to be loaded from, or stored into, a memory location indicated by the contents of DE or BC. This is known as indexed addressing. The only double-precision load and store instructions in the 8080, LHLD and SHLD, transfer the contents of HL to or from a memory location specified by the immediate address following the instruction. This is an example of direct addressing; hence the D in the mnemonic.

The 8085 has two operations that will load or store the double-precision accumulator HL to or from memory location pairs indicated by the contents of DE, an example of indexed addressing. Since X is the usual designator for indexed addressing, our new instructions are LHLX and SHLX. These new ops will find use in storing 16-bit quantities in a table, or fetching them from a table, with the contents of DE being the index pointing into the table.

Another New Flag Bit

Wolfgang Dehnhardt and Villy M. Sorensen (see Reference 1) have named the flag register bit 1 the V flag, for double-precision overflow. When I tested the new op codes on my 8085, the execution of RDL was the only action in which this bit took part. When the most significant bit of DE was a one, the left rotate of it into carry caused this bit to also appear in the V flag. Since it also appears in the carry bit, I see no reason for the V flag, nor the instruction used to test it.

All other flag bit tests cause a transfer of program sequence to a new address spe-

The 8080 has secrets, too

Way back in the ancient past when the world was new and my 8080-based development system had only 4K bytes of main memory, I laboriously tried out the unspecified op codes on the 8080 CPU. I don't recall how far down the list I got, but after setting up various initial conditions for all the registers and executing the op codes 00, 08, 10 et al, in turn, I decided that all were true no-ops and didn't have any effect on the contents of registers or the progression of program execution. But I didn't take the time to try the complete set.

While devising the routines used to investigate the 8085's secret op codes, I once again tried all the unspecified operations on the old 8080. I discovered that even the 8080 had its secrets.

In the 8080, all the unspecified operations up through 38 execute as true no-ops. When I tried the op code CB, I got a belated shock. CB does the same thing as C3, which is the unconditional jump to the address contained in the two bytes following the op code. This is explicable when you consider that there is only a 1-bit difference between C3 and CB, which is obviously not tested by the decoder.

The next op code to test was D9. With main memory filled with halt op codes (76), I set up some initial register contents and executed D9 00 00. The CPU halted at location 0030, indicating that D9 executed the same as RST 6, which has on op code of F7.

Since there was such a disparity between the bit patterns of these two op codes, I tried executing D9 76 76. If D9 did execute as RST 6, I should end up back at 0030. If D9's execution involved an address contained in the following two bytes, I should expect a halt at 7676. If D9 acted as a no-op, the 76 following it in the test sequence would cause a halt at that location. What happened? None of the above.

The memory address space of my system is no longer the mass of emptiness it once was. A 32K byte main memory RAM board occupies locations 0000 through 7FFF. A bit of emptiness exists from 8000 through BFFF. ROMs occupy most of the space above C000, except for two display memory images. I could not set halt traps at every memory location above 8000; when I executed D9 76 76 and didn't get a halt at the expected addresses, I couldn't be sure where the program counter had jumped to.

But it did jump. It ended up halted in the middle of an instruction in ROM near the top of the address space, with the stack pointer decremented by four.

At this point I had to give up the investigations. Without a surefire way to single-step and lots of time for tracing things out, I don't know how the 8080 executes D9, nor the other three remaining unspecified op codes.

Perhaps some other investigator can continue with these experiments. But to be sure you know exactly what the execution of each op code does, you will have to try all possible combinations of initial register contents. I once read that fully testing an 8080 by executing all the legal op codes with all possible combinations of register contents, running at full CPU speed, would take over 200 years. Since the investigations we are describing here have to run at human operator speed, to allow time to analyze results, I don't think we will be hearing from another investigator for a while!

```
          *    "VALUE" IS AN IMMEDIATE BYTE OF DATA AND CAN BE
          *    DEFINED BY THE USE OF ANOTHER "DB"
          *    OR SYMBOLICALLY AS IS SHOWN HERE.  "DEST" IS THE
          *    DESTINATION  ADDRESS OF THE CONDITIONAL JUMP.

0057 =         VALUE  EQU    87            ; EXAMPLE IMMEDIATE BYTE
1234 =         DEST   EQU    1234H         ; EXAMPLE JUMP DESTINATION

2000                  ORG    2000H

2000 08               DB     08H           ; DSUB  B
2001 10               DB     10H           ; RHR
2002 18               DB     18H           ; RDL
2003 20               DB     20H           ; RIM
2004 2857             DB     28H.VALUE     ; DMOV  D.H
2006 30               DB     30H           ; SIM
2007 3857             DB     38H.VALUE     ; DMOV  D.SP
2009 CB               DB     0CBH          ; RSTV
200A D9               DB     0D9H          ; SHLX
200B DD               DB     0DDH          ; JND
200C 3412             DW     DEST          ; DESTINATION FOR JND
200E ED               DB     0EDH          ; LHLX
200F FD               DB     0FDH          ; JD
2010 3412             DW     DEST          ; DESTINATION FOR JD
```

Program listing.

cified in an address field following the instruction, with the exception of the conditional RETURN instructions. It would seem *reasonable* to test the V flag with a "jump on V" or "jump on not V," but instead, the 8085 used the last available op code, CB, as a conditional restart. If the V flag is set, executing CB will cause a restart at location 0040, with the old program counter pushed onto the stack.

The 8080 family already had eight software interrupts, the restart (RST n) instructions. When executed, they cause the contents of the program counter to be pushed onto the stack; a jump is then made to a

memory address equal to 8 times n. For example, RST 6 results in a jump to location 0030, which is 8 times 6 in hex. There is no precedent for selecting a mnemonic for a conditional restart, and Dehnhardt and Sorensen call this one RSTV. I'll buy that.

How to Use the New Instructions

You are a rare bird if you have written your own assembler or have the source listings of the assembler you use. If so, you can incorporate the new instructions into your assembler.

Otherwise, the technique illustrated in the program listing is the best alternative. The quotes here signify that this listing doesn't make any sense, but shows how to incorporate these new instructions into a program, using any standard 8080 assembler. The DB and DW pseudo-ops are used to create the proper machine-language op codes. The mnemonics are then shown in the comment field, for human readability. This listing itself can be posted next to your terminal to show you the form to use for getting these new instructions into your programs.

Apologies and Alarums

I want to thank the authors who first pointed out the existence of the 8085's secret goodies, and also apologize to them for not having accepted *all of their* mnemonics as proposed. I frankly feel that mine are closer to what Intel would have specified, and they are what I will be using.

So many years ago that I shudder to think of it, I was temporarily employed by a long-defunct company that tried to compete with IBM head on. We built what I believe was the first microprogrammed computer in existence. It emulated a number of IBM machines, so could replace all of them. By loading a different microprogram, our computer appeared to be a different machine altogether. I still feel that it was a super product in its time, but the project ran into trouble because this machine would only emulate the "legal" IBM instruction set.

Just as we are on the verge of doing here, programmers in those days discovered and used op code field bit patterns that IBM chose not to recognize, document or support. Tons of software had been written that would not run on our emulator because, being micro-coded, it was not an exact hardware twin of the target machine.

But these same programmers would also have been in trouble if IBM had then delivered a computer that did not execute the illegal instructions the same way, either. And these programmers would have had no reason to complain; no one promised them that newer computers would execute their homemade instructions in exactly the same way.

Now we are treading on this same thin ice, making use of instructions that may exist in today's Intel 8085s, but might disappear in next week's production run. And, of course, Intel isn't the only source of 8085 microprocessors.

Before I began these investigations, I collected 8085s from two Intel batches made over a year apart. I have three of these, and they all seem to execute all the new op codes in the same way. I also have NEC 8085s that do crazy things with these same illegal instructions.

With two spare Intels for backup, I plan to continue to use some of the secret op codes in my own system for my own use. But it wouldn't be a good idea to incorporate them into a product slated for mass production. If Intel intended to support these instructions in the future, they would have included them in their documentation. Be forewarned.■

References

1. "Unspecified 8085 Op Codes Enhance Programming," Wolfgang Dehnhardt and Villy M. Sorensen, *Electronics*, January 18, 1979, p. 144.
2. "MCS-85 User's Manual," Intel Corp., Santa Clara, CA.

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Are you disgusted with cassette-tape program storage problems and the endless wait when loading your BASIC interpreter or other long programs? The answer is a disk system. If you can't afford to buy that disk system now, here is a solution to the frustrations of long loading times.

Using your SWTP 6800 system and a short loader routine, you can keep your BASIC interpreter resident in EPROM as firmware and move it rapidly and automatically from EPROM to RAM, where it will start itself. The EPROM area of the SWTP MP-A2 board is a natural for this application, but if your system doesn't have the SWTP MP-A2, then the alternative EPROM board described can be an attractive replacement. Don't throw your cassette recorder and tapes away yet, since you'll need them to set up this method and for any future changes or additions to your system's firmware capabilities.

Are you thinking that it's a waste of memory space to move from EPROM to RAM to run a program? There is some truth to this, but read on anyway and look at some of the advantages you gain to offset the use of more memory.

Advantages

- Using the loader routine, any program resident in firmware can be called up and run almost as fast as you can type "J" (for jump) $DFAA at your terminal.
- You can start programs without manually typing the program execution address into $A048–49 (program counter).
- Program code remains unchanged.
- The loader routine is relocatable and may be located anywhere in memory.
- EPROMs may be erased and reprogrammed when your system needs to be changed.
- Cost of EPROMs and DSD P/R-32K (bare board only) is around $270. (If you have a smaller program or interpreter, the cost will be less because fewer EPROMs are required.)
- Best of all, you can spend your time in more productive areas rather than trying to modify your interpreter or programs to execute in EPROM. Programs can be written verbatim from MIKBUG- or SWTBUG-formatted cassette tape into EPROMs.

System Requirements

- SWTP 6800 microcomputer system.
- 12K bytes of RAM for BASIC.
- SWTBUG (or MIKBUG) monitor.
- 8K bytes of EPROM (Intel 2716).
- SWTP MP-R EPROM programmer or equivalent.
- SWTP MP-A2 microprocessor board or equivalent.
- SWTP BASIC version 2.0.

Implementation

Implementing this addition to your system will take an evening. For this investment in time, once the program is implemented, you will no longer have to hassle with tape and cassette interface problems.

Load BASIC into memory, add the EPROM-to-RAM loader routine (see Table 1) and then make four 2K cassette tapes. If you have at least 10K of memory available in your system, then you can use one 8K tape, since each EPROM holds only 2K. Program and verify each EPROM, then insert the EPROMs into the SWTP MP-A2 board and check the DIP switches for proper position. Then you should be using "painless instant BASIC" with a few keystrokes.

First, load your BASIC interpreter program (or any other program you want as firmware) into RAM memory using the conventional tape interface method, but don't type G or start your program yet. Use the memory examine/change (M) function of the monitor to load the loader routine (Table 1) into memory right after BASIC. The memory you format now will ultimately reside in EPROM.

Now save BASIC and the loader on cassette tape. Using your monitor examine/change function, set $A002–3 to $0000 and $A004–5 to $07FF and save the first 2K bytes on cassette tape in SWTBUG format. Repeat this process three more times (changing $A002–5 to each new 2K boundary) until the entire 8K interpreter has been saved on good cassette tapes. Label each cassette as it is saved.

To prove that the program you saved is error free, turn your machine off, then load the four tapes you just saved back into the microcomputer. When loading is complete, set the program counter ($A048–9) to $0100 (the cold-start point for BASIC) and type G. If no recording or playback errors occur, the interpreter should come up and run normally. This step could save you the problem of writing an error into EPROM, so don't try to cut corners. Turn the computer off and plug in the SWTP MP-R programmer board.

Now that you are sure that you have a good copy of BASIC (and that your cassette interface is working properly), load the SWTP MP-R software into your machine and write the four cassette tapes into four EPROMs, carefully marking each EPROM after it is programmed. If you have never used the SWTP MP-R programmer before, you may want to play with it awhile before attempting to program your EPROMs. Note: Like any MOS device, EPROMs are sensitive to damage from static electricity, so

```
     C000         EPROM   EQU    $C000       EPROM START ADDR
     0000         RAM     EQU    0           RAM START ADDR
     1FA9         RAMEND  EQU    $1FA9       RAM END ADDR
     A042         STACK   EQU    $A042       MONITOR STACK ADDR
     0100         START   EQU    $0100       BASIC COLD START ADDR
*
1FAA 8E BFFF      LOADER  LDS    #EPROM-1    ADDR OF EPROM BASIC-1
1FAD CE 0000              LDX    #RAM        ADDR OF RAM START
1FB0 32           GETBYT  PUL A              GET BYTE FROM EPROM
1FB1 A7 00                STA A  0,X         STORE BYTE IN RAM(X)
1FB3 08                   INX                INCREMENT RAM POINTER
1FB4 8C 1FAA              CPX    #RAMEND+1   FINISHED?
1FB7 26 F7                BNE    GETBYT      : NO, GET NEXT BYTE
1FB9 8E A042              LDS    #STACK      : YES, SET STACK POINTER
1FBC 7E 0100              JMP    START       EXECUTE BASIC
```

Table 1. Instant BASIC Loader routine.

avoid handling them by the pins and observe the same precautions you would use for any MOS device.

Turn off the power to your machine and remove the SWTP MP-A2 board from your system. Carefully insert each EPROM into its proper socket and configure the DIP switches for operation with 8K of EPROM in location $C000–DFFF. The EPROMs are fragile and expensive, so we strongly recommend the use of sockets and the exercise of great care and patience when inserting the EPROMs into their sockets to avoid bent pins and broken packages.

Once you are sure that all EPROMs are properly seated and the SWTP MP-A2 is properly configured, plug it into the microcomputer and turn on the power. If your system uses the SWTBUG monitor, you can type J $DFAA to start BASIC. If you use MIKBUG, you will have to set the program counter ($A048-9) to the EPROM starting address of the "Instant BASIC Loader routine" and type G to start the loading sequence. Your terminal should respond with READY, indicating that your EPROM resident BASIC has been successfully loaded into RAM and is functioning.

How It Works

The loader routine listed in Table 1 moves the BASIC interpreter from EPROM (1C000–DFFF) to RAM ($0000–1FFF) and jumps to the cold-start address ($0100) of the BASIC interpreter. The loader routine uses the stack pointer to index EPROM and the index register to index RAM during the move from EPROM to RAM. The loader routine resides in EPROM and executes in EPROM.

If your system doesn't include the SWTP MP-A2 board, you can purchase the bare DSD P/R-32K EPROM/RAM board from Digital Service and Design (PO Box 741, Newark, OH 43055) for $27. Sufficient instructions are included with the board to permit an experienced assembler to acquire the necessary parts and assemble the board. Contact Digital Service and Design concerning an assembled and tested EPROM/RAM board. Use the same EPROM method as described above to program and put the EPROMs on the DSD P/R-32K board. The DSD P/R-32K has four independently addressable 8K byte memory blocks, which allow four 8K blocks of EPROM or compatible RAM.

You can use other programs and 6800 system configurations with this method as long as you have EPROM space in the microcomputer. We currently have SWTP BASIC 2.0 and the SWTP EPROM programmer software in EPROM and plan to add a text editor and text processor later.

You can use the loader routine with some modifications to move routines anywhere in memory. Just change the EPROM, RAM and program start addresses to the appropriate locations. Avoid overwriting areas of RAM that you wish to save.

The ease of calling up often-used programs and subroutines from EPROM without the inherent delay associated with cassette tapes or the expense of a disk system is an excellent reason for using this alternative approach. ■

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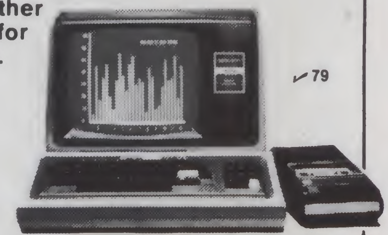

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✓ Reader Service index—page 241

Improving the OSI Challenger C2

Part 2 continues with video, cassette and keyboard modifications.

Ugo V. Ré
167 Sprucewood
Levittown, NY 11756

The model 540 video board is a video interface board with the following hardware features:

- 2K video RAM.
- A 2513 character generator or the optional CG-4 character generator.
- A programmable video display for a 32 × 32 or 64 × 64 character display.
- Normal or reversed video display.
- The analog portion of an audio cassette interface.
- Keyboard interface.

Video Display

The video display utilizes a crystal control clock, which feeds a divider chain to provide the horizontal and vertical sync pulses and the row and column addresses to access the display memory. The board typically operates with the display memory consistently feeding its data to the character generator and then to the display. The CPU, however, can access this memory so that it can be written into or read from just like any other memory location.

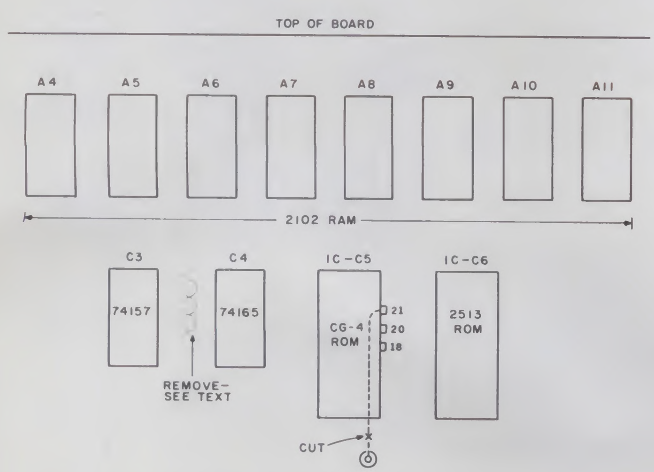

Fig. 1. Character generator component location.

Character Generator

The 540 board may come with a 2513 character generator ROM to provide 64 uppercase ASCII characters or OSI's CG-4 ROM that provides 256 numeric, graphic and gaming elements displayed in an 8 × 8 dot array.

You must make the following board modifications to convert from the 2513 ROM to the CG-4 ROM:

1. Remove the 2513 ROM, which is no longer needed and can be discarded.
2. At the spare 24-pin socket at C5, check for a ground on pin 20 and +5 V on pins 18 and 21 (see Fig. 1).
3. Cut the foil trace that runs on the component side of the board from pin 20 to a feed-through hole at the bottom of the socket.
4. Install a jumper between pin 20 and pin 21 of the socket.
5. Check for +5 V on pins 18, 20 and 21.
6. Locate four wire-wrap pins between the 74165 and 74157 IC, locations C3 and C4 (see Fig. 1).
7. Remove the jumpers that strap these pins together.
8. Install four 2102 RAMs in the spare memory sockets at locations A7, A8, A15 and A16.
9. Install the CG-4 ROM in the socket at location C5.
10. Run the Character Generator Test program (Listing 1). The generator should display 256 separate characters.

```
10 FOR CL = 1 TO 2048
20 POKE 53247 + CL, 32:NEXT CL
30 LN = 0:AS = 0
40 FOR SP = 1 TO 64 STEP 2
50 POKE 53695 + SP + LN, AS
60 AS = AS + 1:NEXT SP
70 LN = LN + 192
80 IF LN <1536 GO TO 40
```

Listing 1. Character Generator Test program.

You can also replace the character generator with a 2716 EPROM that has been user programmed to provide a completely different font. Either way, the video display will now provide more characters than the basic 64 uppercase of the 2513.

After the data leaves the character generator, it goes to an eight-bit parallel shift register and then through two in-

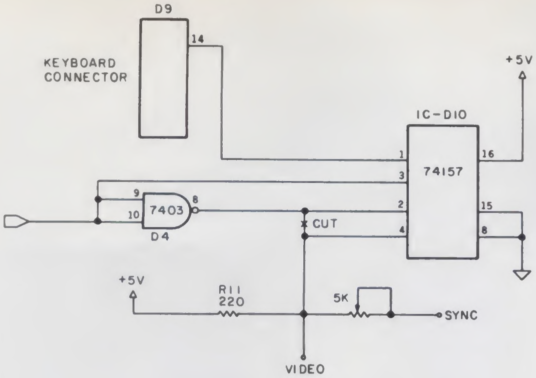

Fig. 2. Reverse video circuit.

	characters/line		character color	
Data	32	64	White	Black
0	X		X	
1		X	X	
2	X			X
3		X		X

Table 1. Screen options. Address DEXX hex (56900).

verting buffers to the mixing circuit, where it is combined with the horizontal and vertical sync to produce the composite video signal.

Screen Size and Reverse Video

The 540 schematic notes indicate that the inverters may be bypassed for reverse video. Although this is a desirable feature, it would be better to be able to reverse the video signal under program control similar to the operation of changing the screen size.

A one-bit programmable latch is used to control the screen size. A 7474 IC (dual D flip-flop) is addressed and triggered to pass on the status of data bit 0 and 1. The status, a low or high, is latched by the flip-flop and used to activate a 74157 IC (1 of 2 data selector), which will then route one of two signals to other logic circuits.

In the case of the screen size change, one half of the 7474 uses the status of data bit 0 to select the clock signal directly and feed it to the dot clock and address counter chain or to select the clock signal divided by two and then feed it to the dot clock and address counter chain. If data bit 0 is low, then the screen size will be 32 × 32, which will provide a symmetrical dot array for graphics, plotting and video games. A high will give the standard 32 × 64 display.

The other half of the 7474 uses the status of data bit 1; however, the latched signal is not used to control any other logic circuit. I used this latched signal to control a new data selector that routes the video signal directly to the mixing circuit or bypasses one buffer and then routes the video signal to the mixing circuit (see Fig. 2).

Make the following modifications to implement the programmable reverse video:

1. Install a 16-pin IC socket at location D10, a prototype area (see Fig. 3).

2. Run four wires from IC socket D10, pins 1, 2, 3 and 4 to ICD9 socket, pin 14; ICD4, pins 8 and 10; and to R11 (see Figs. 2 and 3).

3. Jumper pins 8 and 15, ICD10 to the ground bus at the bottom of the IC.

4. Jumper pin 16, ICD10, to the +5 V bus at the top of the IC.

5. On the component side of the board, cut the foil trace from R11 to ICD4, pin 8. The trace is under the chip and appears at the top of the chip (see Fig. 3).

6. Check wiring, then install a 74157 in socket D10.

7. Turn on the computer. The video display should be the standard 32 × 64 display with white characters.

With the completion of this modification, you will have the ability to select four video display formats under program control (see Table 1). Although the video can now display both black and white characters, it cannot display both at the same time. In addition, you will have to adjust the video monitor controls to provide the sharpest characters in both the black and white display.

Audio Cassette Interface

The May issue of *Kilobaud Microcomputing* contained an article ("High-Speed Cassette Interface," p. 42) describing the construction of a high-speed cassette interface. I used this information to modify the cassette interface.

The 540 board contains all of the components that make up the analog input and output portion of an audio cassette port. In conjunction with the 6850 ACIA on the 500 board, the interface is able to provide off-line data storage to an audio cassette.

A printer or data set will not work with the serial interface while the cassette transmit and receive leads are wired to the 540 board. Therefore, it is necessary to open these leads when you use the serial interface to operate a printer. I used a three-pole on-off switch to open the cassette transmit and receive leads and remove the ground from the $\overline{CTS}$ lead (see Fig. 4). The printer grounds the $\overline{CTS}$ lead when it is attached to the EIA connector and the power is on.

The audio cassette interface uses the Kansas City Standard format for converting the data bits to an audio signal that is recorded on the cassette. The Kansas City Standard is an FSK (frequency shift keying) system that keys a change in the binary value transmitted by a change in frequency. The 0s and 1s from the computer are converted to two different frequencies, 1200 Hz and 2400 Hz, which are then converted to a sine wave and recorded on an audio cassette. On playback, the receiving circuit detects the frequency shifts and converts them into 0s and 1s for input to the computer.

The cassette interface is normally operated at 300 baud. At this rate, a data zero is four full cycles of 1200 Hz, and a one is eight full cycles of 2400 Hz. If the interface were operated at 1200 baud, the cycles would be one-quarter of the 300 baud rate. A data zero is then one full cycle of 1200 Hz, and a one is four full cycles of 2400 Hz.

The transmitter circuit (Fig. 5) consists of a 7476 IC (dual JK flip-flop) wired to divide the clock by two or divide by four. To produce the 1200 Hz and 2400 Hz, the clock frequency must be

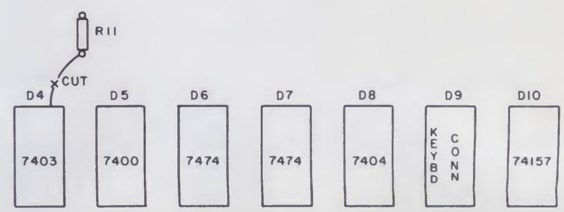

Fig. 3. Reverse video component location.

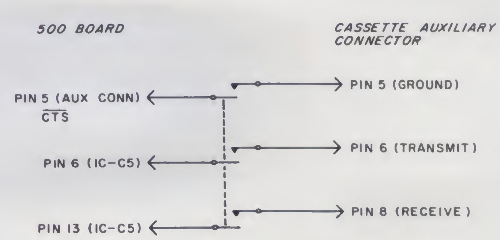

Fig. 4. Printer/cassette select switch.

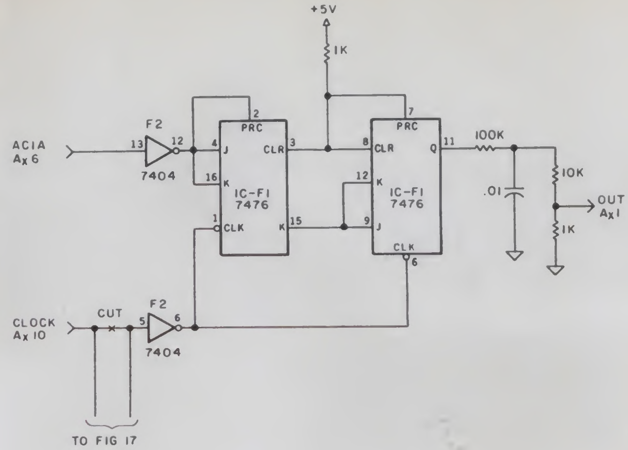

Fig. 5. Cassette transmit circuit.

4800 Hz, which is available from the 6850 clock circuit when it is operating at the 300 baud rate. However, when operating at the 1200 baud rate, the clock frequency increases to 19200 Hz.

For the transmit circuit to work at the 1200 baud rate, the 19200 Hz clock must be divided by four to produce 4800 Hz, which is needed to clock the JK flip-flop. A new 7474 IC (dual D flip-flop) is wired to divide the clock by four (see Fig. 6), while one-half of 74123 (dual monostable multivibrator) is wired to control the operation of the 7474.

Circuit Operation

At 1200 baud the 74123's clear lead is grounded through the baud rate selector switch (see Fig. 5, part 1). This inhibits triggering; the 74123 $\overline{Q}$ and 7474 clear pins go high; and the circuit divides normally. The 19200 Hz clock is divided by four and fed to the 7404 inverter (Fig. 5), where it is then converted to 2400 Hz or 1200 Hz by the operation of the 7476.

At 300 baud the 74123 clear lead is high. As the ACIA clock changes from high to low, the circuit triggers and makes the $\overline{Q}$ lead low, which then clears the 7474 IC. The overall effect is to pass the ACIA clock frequency through the 7474 without dividing it.

The 1200 Hz and 2400 Hz from the 7476 IC are then sent to a low-pass filter, which rounds off

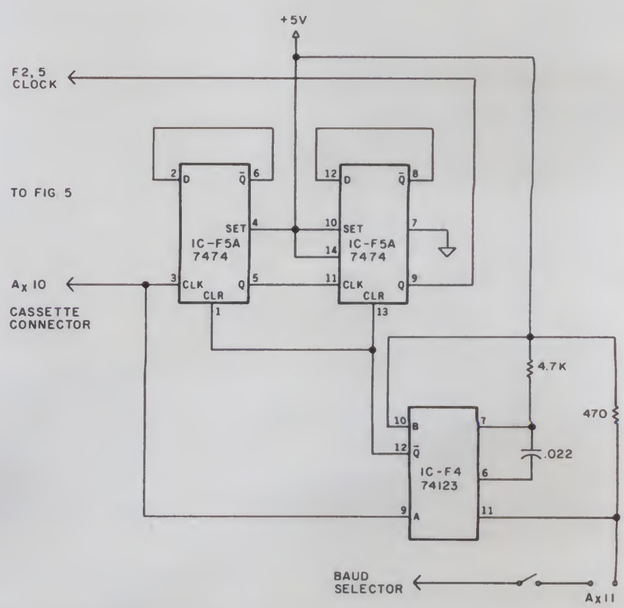

Fig. 6. Cassette 1200 baud modification circuit.

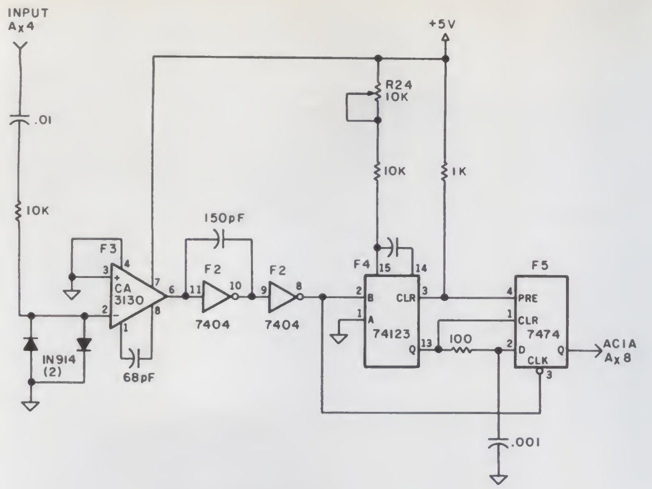

Fig. 7. Cassette receive circuit.

the square wave to provide a sine wave to the tape recorder (see Fig. 5).

The sine wave from the audio cassette is limited and converted to a square wave and then fed to one-half of a 74123 (monostable multivibrator) and one-half of a 7474 (D flip-flop). See the receive circuit in Fig. 7.

The 74123 is adjusted for a frequency between 1200 and 2400 Hz, which will constantly retrigger the 74123 and produce a constant high output, which will be clocked through the 7474 to produce a 1. 1200 Hz will clock through the circuit and produce a 0. The 0 and 1 are then sent to the 6850 chip.

Cassette record and play at 300 baud and 1200 baud is now possible with the following modification steps (see Fig. 8):

1. Install a 14-pin IC socket at location F5A.
2. Jumper pin 1 to 13, 2 to 6, 5 to 11 and 8 to 12 on the 7474.
3. Jumper pin 7 to ground.
4. Jumper pins 4, 10 and 14 to +5 V.
5. Install a 4.7k resistor between +5 V and pin 7 of the 74123 at location F4.
6. Install a .022 uF capacitor between pins 6 and 7, ICF4.
7. Install a 470Ω resistor between +5 V and pin 11, ICF4.
8. Jumper pin 10 of ICF4 to +5 V.
9. Jumper pins 9 and 12, ICF4, to pins 3 and 1, ICF5A.
10. Cut foil trace at pins 10 and 11 of the cassette auxiliary connector.
11. Run three wires from pin 11 and 10 of the connector and ICF2, pin 5, to ICF4, pin 11, and ICF5A, pins 3 and 9.
12. Run a wire from the auxiliary plug, pin 11, to the 1200 baud pin of the B part of the baud select switch (see Fig. 5, part 1).
13. Install a 7474 IC in socket.
14. Connect an amplifier to the cassette interface input/output jacks. Adjust the volume at the midpoint.
15. Connect a logic probe to pin 6 of the cassette auxiliary connector. It should be high.

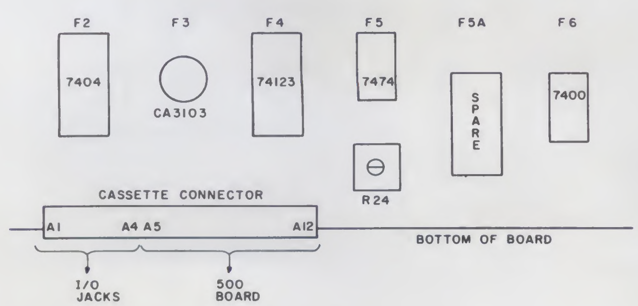

Fig. 8. Cassette component location.

address	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
022	A9	00	AA	A8	85	A0	85	A1	85	A2	85	A3	AD	00	FC	4A
023	4A	90	F9	A5	A0	8D	01	FC	AD	00	FC	4A	90	FA	AD	01
024	FC	C5	A0	D0	0F	E6	A0	D0	E3	E6	A2	D0	DF	E6	A3	D0
025	DB	4C	00	FF	85	A1	A9	4D	4C	46	FF	—	—	—	—	—

Listing 2. Cassette I/O Loop Test program.

address	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
026	A0	00	84	A0	AD	00	FC	4A	4A	90	F9	A5	A0	8D	01	FC
027	88	D0	04	E6	A0	F0	03	4C	64	02	4C	00	FF	—	—	—
028	A0	00	AD	00	FC	4A	90	FA	AD	01	FC	99	00	D4	C8	4C
029	82	02	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Listing 3. Cassette Record/ Play Test program.

Connect a logic probe to pin 8 of the cassette connector. The pin should be high; if not, adjust R24 (see Fig. 8) until it goes high.

16. Ground pin 6 of the connector. Pin 8 should now be low; if not, adjust R24 until it goes low. Remove ground and check that pin 8 goes high.

17. Recheck that pin 8 is low when pin 6 is grounded and high when not grounded. This is the only adjustment at this time for the interface to operate.

18. Run the test program in Listings 2 and 3.

Listing 2 tests that the byte received is the same as the one transmitted. Listing 3 records the characters on a tape, which is then played back and displayed on the screen. There is no comparison made between transmit and receive data, except what is displayed on the screen.

Test Setup

Connect the amplifier or cassette to the input/output jacks and adjust the volume at the midpoint. Type in the machine-language program for the Cassette Loop test (Listing 2) and the Cassette Record/Play test (Listing 3). (Refer to the C2 or 500 board manuals for instructions on entering machine-language programs into the computer. The cassette interface should first be tested at 300 baud. If there are no problems, then test the 1200 baud operation.)

Listing 2 will check 256 characters continuously for 65,000 cycles. Load the starting address 0220 and press the G key. (Restart test if address 0220 immediately changes to 0000. This may happen once or twice; however, the program should run without any problem at 300 baud. If it fails to run, check the amplifier's connections and volume setting.)

When the program fails to compare the character received with that transmitted, it will bring up address 0000 on the screen. (Memory address 00A0 to 00A3 will load with the information needed to analyze the failure.)

Access address 00A0 for the character transmitted and 00A1 for the character received. (The information is in hexadecimal and must be converted to binary so that the bits can be compared.) Access address 00A3 and 00A2 to compute the number of cycles completed. (A3 is the high byte, and A2 is the low byte in hexadecimal.)

Rerun the test until there are no failures in 20,000 cycles (5000 hex). I have found that it is necessary to adjust R24 and increase the system clock to eliminate receive problems when the cassette interface is operated at 1200 baud. When this test is complete (at 1200 baud the computer completes 1420 cycles per hour), run the Record/Play test.

I was able to use my cassette recorder (Radio Shack CTR-39) connected normally. A blank cassette (no tape) is placed in the recorder and the Record/Play buttons are operated. The input signal is amplified and sent to the ear jack. During record, the volume control is inoperative; however, the amplified signal is more than adequate to drive the cassette interface.

To run Listing 3, operate Record/Play on cassette, load the starting address 0260 hex and press the G key. When the program is complete the C/W/M? will appear.

COLUMN

ROW / BIT	7	6	5	4	3	2	1	0
7	1	2	3	4	5	6	7	
6	8	9	Ø	:	---	RUB OUT		
5	.	L	O	LF	CR			
4	W	E	R	T	Y	U	I	
3	S	D	F	G	H	J	K	
2	X	C	V	B	N	M	,	
1	Q	A	Z	SPACE	/	;	P	
0	REPT	CTRL	ESC			L SHIFT	R SHIFT	SHIFT LOC

KEY CONTACT

Table 2. Keyswitch matrix.


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Access the machine monitor and load the address 0280 hex. Press the G key, and then operate Play on the cassette.

An ASCII character will be displayed 256 times on the screen before a new character is displayed. All 256 characters will be displayed before the program is completed. By observing the screen, you can detect any failures (a different character appears in place of the character being displayed).

These programs were run at 300 and 1200 baud. There were no errors at 300 baud. At 1200 baud there were many errors, which I eliminated after I increased the CPU clock to 1.58 MHz. After several months use at the 1200 baud rate, I have not had any problem; however, I do maintain a backup of all programs recorded at 300 baud.

542 Keyboard

The 542 polled keyboard uses 53 keyswitches and the microprocessor to provide the functions of a standard keyboard encoder chip. In normal operation, the CPU writes a byte of data, corresponding to a row of keys, to the keyboard address (DFXX hex). The CPU then reads a byte of data from the keyboard that corresponds to the column of the key closure.

When the CPU finds a key closure, it translates the row and column value to an ASCII code for use by the software seeking input from the keyboard (see Table 2). This polled keyboard has an advantage over a standard ASCII keyboard, which can also be used with the 540 board since it is simple to utilize the keys directly for some specific use.

Listing 4 shows a BASIC program that loads a row address and reads the column address so that complicated operations can be programmed as single keystrokes or multiple simultaneous keystrokes. The versatility of multiple, simultaneous keystrokes is not available when the keyboard is operating in the ASCII mode, since the software monitor provides roll-over protection.

With the polling feature, you can install any arrangement of switches to meet a specific need, including a quasi joystick.

Circuit Board Modification

In the upper corner of the keyboard, there is a prototype area that will accept two or three IC sockets. Follow these steps:

1. Install a 16-pin IC socket on the circuit board.

2. Wire the socket to the eight row address diodes and the eight column address pull-up resistors (see Fig. 9).

3. Use a 16-lead, double-ended DIP jumper cable to connect the keyboard to a specialized keyboard outside the case.

I have added two special keyboards, a hexadecimal keypad (Jameco) and a five-button quasi joystick. The hexadecimal keypad switches are wired to a 16-pin IC socket such that when connected to the main keyboard they will produce the same row and column address as the main keyboard (0 to 9, A to F and three additional keys).

The five-button keypad is wired to produce five column addresses with any one row address (see Fig. 10). With this ar-

POKE 530, 1	The control C must be deactivated before checking for a keystroke
POKE 57088, R*	select row
X = PEEK (57088)*	check column

*The decimal equivalent of the row or column bit is as follows:

on bit	7	6	5	4	3	2	1	0
decimal	128	64	32	16	8	4	2	1

Only one row bit is turned on at a time.
The column value is dependent on the number of keys pressed.

Listing 4. The BASIC program interpreting a keystroke.

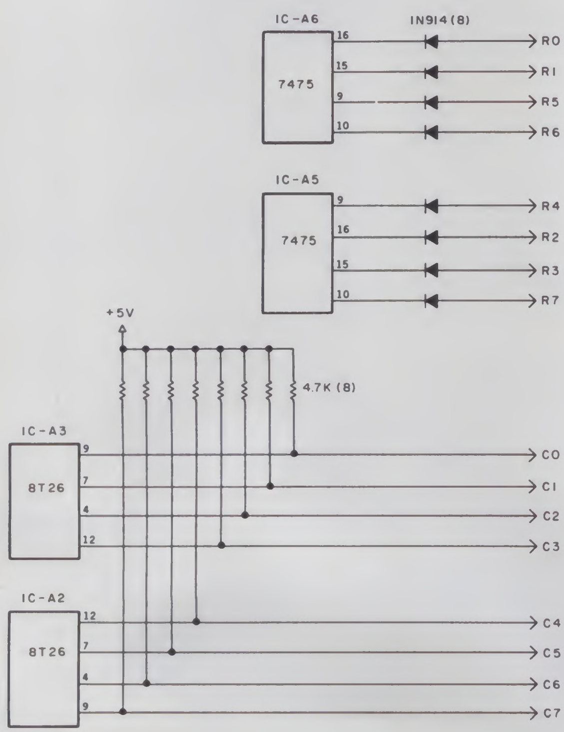

Fig. 9. Keyboard row and column components.

rangement it is possible to define four separate directions (N, S, E and W) with the single keys, and four alternate directions (NE, SE, SW and NW) with a multiple, simultaneous operation of a pair of keys.

You can incorporate the BASIC program in Listing 4 in a larger program that will select a subroutine based on the value of the column address.

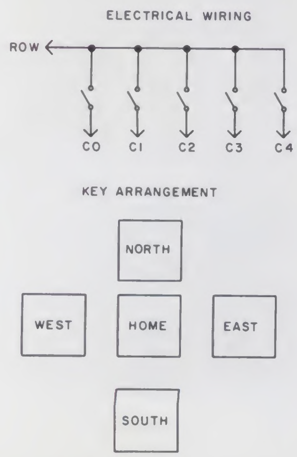

Fig. 10. Five-button joystick.

Conclusion

I completed the modifications over the course of one year, and had little time to develop much software. While there may be some additional room for hardware modifications, in the future I will be concentrating on software development and the study of the BASIC and monitor firmware. ■

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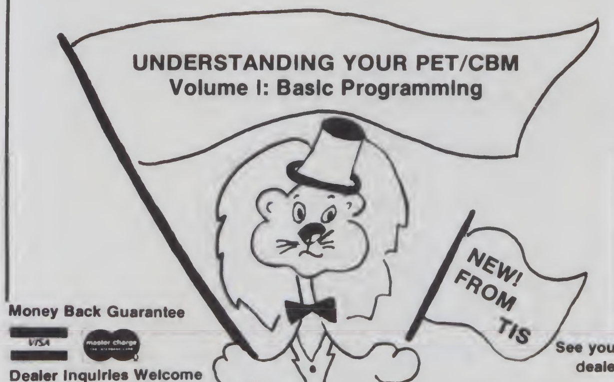

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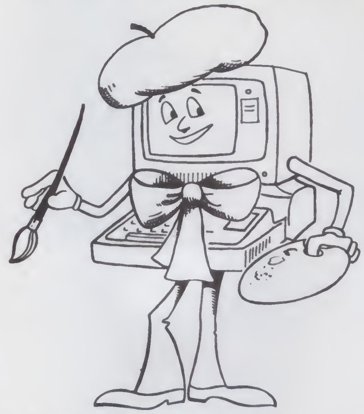

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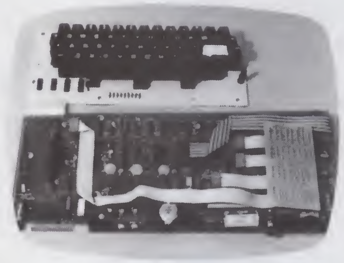

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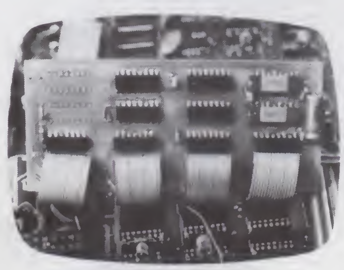

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For most applications, the high-resolution (HIRES) functions provided in Apple-Soft and the HIRES machine-language routines are adequate. However, for applications that require high-speed graphics, a complete memory map is better suited. This map places into one-to-one correspondence each screen coordinate with a memory location. Knowing this relationship would allow you to directly alter memory locations in order to create special or high-speed graphics.

We already know that HIRES screen number 1 resides in memory locations 8192 to 16383 (screen 2 is 16384 to 24575) and that the screen locations occupy a 280 by 192 matrix. What we would like to know is: Where on the screen is, say, memory location 9020? Conversely, where in memory is screen location, say, (140,88)?

The actual mapping is not as simple as you would hope. It would be nice if the lines were consecutive through the memory, but Murphy's Law dictates that we can't be so blessed. The difficulty in finding the exact mapping has been mentioned by other authors: Andrew H. Eliason in "Apple II High-Resolution Graphics Memory Organization," *MICRO*, No. 7, Oct.-Nov. 1978, p. 43, and Darrell G. Smith in "Apple II High-Resolution Graphics," *Kilobaud Microcomputing*, Sept. 1979, p. 104. There are several ways to present the algorithm; I chose a way that allows easy implementation in machine language.

The Y Coordinate

If Y is the line number (from 0 to 191 for full screen graphics), then define:

P = INT(Y/64)
R = Y − 64•P
Q = INT(R/8)
N = R − 8•Q

The starting place in memory for line Y is then given by:

ML = 8192•SC + 1024•N + 128•Q + 40•P

where SC is the screen number 1 or 2. For example, the starting point in memory for line 88 is found by:

P	=	INT(88/64)	=	1
R	=	88 − 64•1	=	24
Q	=	INT(24/8)	=	3
N	=	24 − 8•3	=	0

and if SC = 1, then

```
          SC  =  1
           U  =  444
           N  =  0
           V  =  444
           Q  =  3
           W  =  60
           P  =  1
A   =  8636 − [8192•1 + 1024•0 + 128•3 + 40•1]
    =  8636 − 8616
    =  20
and        Y  =  64•1 + 8•3 + 0
              =  88
          XS  =  7•20 = 140
```

Example 1.

```
0C58  AD 6E 17   LDA $176E   RETRIEVE LINE NUMBER
0C5B  4A         LSR         DIVIDE BY 64
0C5C  4A         LSR
0C5D  4A         LSR
0C5E  4A         LSR
0C5F  4A         LSR
0C60  4A         LSR
0C61  8D 6D 17   STA $176D   STORE P
0C64  0A         ASL         MULTIPLY BY 64
0C65  0A         ASL
0C66  0A         ASL
0C67  0A         ASL
0C68  0A         ASL
0C69  0A         ASL
0C6A  8D 6A 17   STA $176A   TEMP STORE 64*P
0C6D  AD 6E 17   LDA $176E   RECALL LINE NUMBER
0C70  38         SEC         SET CARRY FOR SUBTRACTION
0C71  ED 6A 17   SBC $176A   SUBTRACT 64*P FROM L
0C74  8D 6B 17   STA $176B   SAVE R
0C77  4A         LSR         COMPUTE R/8 =Q
0C78  4A         LSR
0C79  4A         LSR
0C7A  8D 6C 17   STA $176C   SAVE Q
0C7D  0A         ASL         MULTIPLY Q BY 8
0C7E  0A         ASL
0C7F  0A         ASL
0C80  8D 6A 17   STA $176A   TEMP STORE 8*Q
0C83  AD 6B 17   LDA $176B   RECALL R
0C86  38         SEC         SET CARRY FOR SUBTRACTION
0C87  ED 6A 17   SBC $176A   SUBTRACT 8*Q FROM R
0C8A  8D 69 17   STA $1769   SAVE N
0C8D  60         RTS
```

Listing 1. Routine to compute P, Q, N from line number.

ML = 8192•1 + 1024•0 + 128•3 + 40•1
= 8616

The X Coordinate

Each line has 280 points (labeled 0 to 279) stored in 40 bytes. The last bit of each byte (towards HIMEM) is not used in a four-color machine. (In a six-color machine it is.) The organization is: 7 bits/byte • 40 bytes/line = 280 bits/line. Given X, the byte number of 40 is

S = INT(X/7)

and the position in the byte is

T = X − 7•S

For example, if the X coordinate is 145, then

S = INT(145/7) = 20
T = 145 − 7•20 = 5

So for screen coordinate (145,88), the memory location is 8616 + 20 = 8636, the fifth bit.

Going the Other Way

Now that we can convert X and Y to a memory location, to go the other way is easy. Given a memory location M:

SC = INT(M/8192)
U = M − 8192•SC
N = INT(U/1024)
V = U − 1024•N
Q = INT(V/128)
W = V − 128•Q
P = INT(W/40)
A = M − [8192•SC + 1024•N + 128•Q + 40•P]
= M − ML
Y = 64•P + 8•Q + N
XS = 7•A

There is ambiguity in going from a memory location M to coordinates (X,Y) since there are seven horizontal positions in a given byte. To check these formulas, we can try to work back from memory location 8636 to (X,Y). Now that you know how to use these formulas, I'll just give the answers (see Example 1).

Machine-Language Programs

Most applications require finding the memory location given the coordinates (X,Y). It would be easy to compute the value of M from X and Y in Integer BASIC, especially since the divisions will automatically give the required integer part. But if we want truly high-speed graphics, why not use machine language? Notice that we only multiply and divide by powers of 2 (even 40 is the sum of 32 and 8), so that machine-language programs are especially tempting.

The following programs were the first I wrote for my Apple II. They are crude and inefficient; however, they work and are fast. Because they use brute force in their logic, I hope they are clear to beginners. The routine in Listing 1 computes P, Q and N from Y.

Y is placed in \$176E
P is stored in \$176D
Q is stored in \$176C
R is stored in \$176B
Temp storage, \$176A
N is stored in \$1769

The routine in Listing 2 then takes the results from above and computes M.

SC is stored in \$176F
Working registers, \$1768,1767
MLO is stored in \$00
MHI is stored in \$01

This routine uses the equation for ML indirectly. Since the output must be a two-byte memory location, the equation was factored so that the high-order and low-order value of M would be separately computed. You could modify the routine to put MLO and MHI wherever you want. (This is done in steps 0CE7 to 0CEF.) I put them in page zero of memory so that I could indirect-address in the following listings.

Application Routines

In order to show how fast these routines can be, I have included two routines that I use. Listing 3 is a routine to draw a blue horizontal line. (A solid blue line consists of D5 AA pairs starting at the zero byte. If you have a four-color Apple, modify the routine at locations 0C34 and 0C42 to be 2A and 55, respectively. This will give you green.) Listing 4 is a calling routine to paint the screen a solid color from line 0 down to a specified line. (Actually, the painting is from the line up.)

The four routines in this article give a solid background color exceedingly fast. Compare it

```
0C94   A9 00      LDA #$00     CLEAR WORKING REGISTERS
0C96   8D 67 17   STA $1767
0C99   8D 68 17   STA $1768
0C9C   AD 6F 17   LDA $176F    RECALL  SCREEN PAGE#
0C9F   0A         ASL          MULTIPLY BY 32
0CA0   0A         ASL
0CA1   0A         ASL
0CA2   0A         ASL
0CA3   0A         ASL
0CA4   8D 68 17   STA $1768    STORE IN HIGH ORDER
0CA7   AD 69 17   LDA $1769    RECALL N
0CAA   0A         ASL          MULTIPLY BY 4
0CAB   0A         ASL
0CAC   6D 68 17   ADC $1768    ADD PREVIOUS HIGH ORDER
0CAF   8D 68 17   STA $1768    STORE BACK IN HIGH ORDER
0CB2   AE 6C 17   LDX $176C    RECALL Q
0CB5   E8         INX
0CB6   CA         DEX
0CB7   F0 14      BEQ $0CCD    CHECK FOR Q = 0
0CB9   CA         DEX
0CBA   F0 0C      BEQ $0CC8    CHECK FOR Q = 1
0CBC   CA         DEX
0CBD   A9 01      LDA #$01     ADD 1 TO HIGH ORDER
0CBF   6D 68 17   ADC $1768
0CC2   8D 68 17   STA $1768
0CC5   4C B5 0C   JMP $0CB5    CONTINUE COUNTING
0CC8   A9 80      LDA #$80     LOAD A WITH 128 ($80)
0CCA   8D 67 17   STA $1767    ADD TO LOW ORDER
0CCD   AD 6D 17   LDA $176D    RECALL P
0CD0   0A         ASL          MULTIPLY BY 32
0CD1   0A         ASL
0CD2   0A         ASL
0CD3   0A         ASL
0CD4   0A         ASL
0CD5   6D 67 17   ADC $1767    ADD TO LOW ORDER
0CD8   8D 67 17   STA $1767    STORE BACK IN LOW ORDER
0CDB   AD 6D 17   LDA $176D    RECALL P
0CDE   0A         ASL          MULTIPLY BY 8
0CDF   0A         ASL
0CE0   0A         ASL
0CE1   6D 67 17   ADC $1767    ADD TO LOW ORDER
0CE4   8D 67 17   STA $1767
0CE7   AD 68 17   LDA $1768    MOVE RESULTS TO $00, 01
0CEA   85 01      STA $01
0CEC   AD 67 17   LDA $1767
0CEF   85 00      STA $00
0CF1   60         RTS
```

Listing 2. Routine to compute memory location from page #, (SC), P, Q, N.

```
0C30   18         CLC          CLEAR CARRY
0C31   A0 00      LDY #$00     START COUNTER
0C33   A9 D5      LDA #$D5     FIRST PAIR FOR BLUE
0C35   91 00      STA ($00),Y  STORE IN MEMORY LOCATION GIVEN
                                BY $00 + Y
0C37   C8         INY
0C38   C8         INY
0C39   98         TYA          MOVE Y TO A FOR CHECK
0C3A   69 D8      ADC #$D8     COMPLEMENT TO 40 ($28)
0C3C   90 F5      BCC $0C33    IF NO OVERFLOW, LOOP BACK
0C3E   18         CLC
0C3F   A0 00      LDY #$00     RESTART COUNTER
0C41   A9 AA      LDA #$AA     SECOND PAIR FOR BLUE
0C43   91 02      STA ($02),Y
0C45   C8         INY
0C46   C8         INY
0C47   98         TYA
0C48   69 D8      ADC #$D8
0C4A   90 F5      BCC $0C41
0C4C   18         CLC          CLEAR CARRY GOING OUT
0C4D   60         RTS
```

Listing 3. Routine to draw a blue horizontal line.

```
0D39   AC 66 17   LDY $1766    RECALL BOTTOM MOST LINE
0D3C   8C 6E 17   STY $176E    PUT INTO $176E
0D3F   20 58 0C   JSR $0C58    COMPUTE P,Q,N FROM LINE
0D42   20 94 0C   JSR $0C94    COMPUTE MHI, MLO
0D45   A5 00      LDA $00      SET UP A PAIR OF ADDRESSES
0D47   69 01      ADC #$01      IN ZERO PAGE FOR ROUTINE
0D49   85 02      STA $02       $0C30
0D4B   A5 01      LDA $01
0D4D   85 03      STA $03
0D4F   20 30 0C   JSR $0C30    DRAW A BLUE LINE
0D52   AC 6E 17   LDY $176E
0D55   C8         INY
0D56   88         DEY
0D57   F0 07      BEQ $0D60    CHECK IF ZEROTH LINE DRAWN
0D59   88         DEY          IF NOT, DECREMENT Y
0D5A   8C 6E 17   STY $176E    SAVE LINE BEFORE SUBR CALL
0D5D   4C 3F 0D   JMP $0D3F    DO IT AGAIN
0D60   60         RTS
```

Listing 4. Main routine.

```
>LOMEM 6000
10 POKE -16304,0        GO TO GRAPHICS
20 POKE -16297,0        GO TO HIRES GRAPHICS
30 POKE -16302,0        FULL SCREEN GRAPHICS
40 POKE 5999,1          SELECT SCREEN #1
50 POKE 5990,XXX        WHERE XXX IS THE LINE DOWN TO
                        WHICH YOU WANT SOLID COLOR
60 CALL 3385            CALL THE MAIN ROUTINE
70 END
```

Listing 5.

to the BKGND function in the Apple HIRES routines or the sequence: /HGR/POKE 28,42/ CALL 62454/ for AppleSoft ROM or /HGR2/POKE 28,42/ CALL 11250 for AppleSoft RAM. Any one of these is considerably slower.

In order to set up these routines, enter them via the monitor. It is faster to enter the hex characters as data than to use the mini-assembler. Then go into Integer BASIC and set LOMEM:6000. The routines are not that large, but I wrote the routines to keep the data out of the way, and it is stored just below 6000. You can also modify this for your own use. Type in the program in Listing 5.

The fact that this program never calls any kind of HIRES routine whatsoever shows the power and simplicity of the formulas. Type RUN/RETURN to see the screen quickly go solid blue (or green), if you choose XXX = 191. If we can paint the entire screen that fast, other, less extensive, graphics ought to be very fast indeed.

The BASIC Program

To get out of the graphics mode, type TEXT/RETURN. Note that if you now run the program a second time, it will paint an already colored screen, and you will have no way of verifying that the action took place. One remedy is to first run the program with zero in locations 0C34 and 0C42. This will clear the screen to black. Or, you could use the Apple HIRES routines that reside in 800.BFF or the programmer's aid. Do not try to use AppleSoft or the C00.FFF routines.

Limitations

These routines were designed to paint large areas of the Apple screen a solid color. If you want to use the mapping formulas to go from point to point, you will have to understand how the color logic works. (See "High-Resolution Color Graphics on the Apple II Computer" by S. Wozniak, Apple Computer Co., November 30, 1977. These convenient HIRES routines that reside in 800.BFF are available from Apple.)

For now, if you want to do some experimenting to find out what a solid color looks like, use this sequence: /HGR/POKE 28,NNN/CALL 62454/RESET/2000L/RETURN. The results are shown in Table 1.

NNN	Color	Pairs in memory
00	black	00 00
42	green	2A 55
85	purple	55 2A
127	white 1	7F 7F
170	orange	AA D5
213	blue	D5 AA
255	white 2	FF FF

Table 1.

Conclusion

The physical outlay of the memory mapping of the Apple II HIRES graphics has been shown along with some application examples on how to paint various areas of the screen. The examples are not intended to be anything but instructive unless you have a specific use for them (like I did). Evidently, there is a lot more to the Apple than meets the eye! Now you can get a start on high-speed graphics in machine language just by creating the proper data in memory. ■

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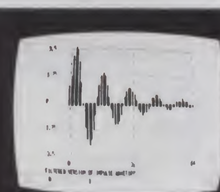

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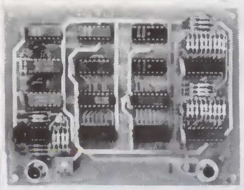

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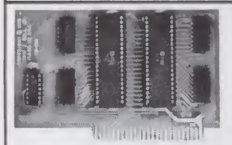

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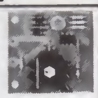

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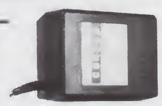

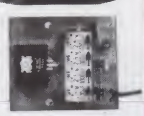

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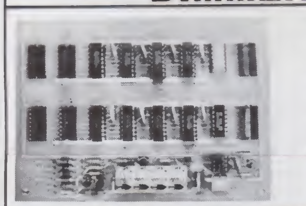

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A Better Assembler/Editor For the H8

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Many H8 users have tried, and found it difficult, to learn 8080 assembly-language programming using Heath's TED-8 editor and HASL-8 assembler. This article tells you how to create your own efficient editor/assembler that is satisfying to use and makes programming in assembly language almost as easy as doing it in BASIC. A disk system is not required.

Before I got an H8, I assembled and used an SWTP 6800, which comes with an editor and assembler that are linked together and are co-resident in memory. This means that to program, you load the editor/assembler program from tape and it stays in RAM as long as you need it. You can jump back and forth between the two without the slightest delay. Once you have used one like that, there is no way you are ever going to accept the inconvenience of a TED-8 and HASL-8.

Documentation for the 6800 microprocessor is in hexadecimal. It is simple enough to learn, and once you are familiar with it, you can see why hex is the industry standard. For machine-language programming, it is more efficient and easier to use than octal or decimal.

Perhaps you have noticed that most 8080 programs that are available in assembly listing form are in hex. For example, Technical System Consultants offers several excellent 8080 programs at reasonable cost. Each one comes with an assembly-language source listing, which is a fundamental requirement for any program to be relocated for H8 use. You need a hexadecimal program loader, such as the one in CONOPS (see *Kilobaud Microcomputing*, July 1979), for program entry.

Console Driver	2040 -2163
Editor	2164-25D2
Assembler	25D3-3D53
RAM for Editor temporary storage	3E00-3E5B
Stack	3E5C-4000
TBPTR	4000
LNUM	4002
Text Buffer	4004-57FF
Symbol Table	5800-5FFF
Object Code Buffer	6000-6B5F
Read TSC Tape	6B60-6BFF
CONOPS	6C00-6F20

Table 1. Memory assignment for the co-resident editor/assembler.

Requirements

For my H8 I wanted an 8080 equivalent to the 6800 co-resident editor/assembler that I have just described. The 8080 Standard Editor from Scelbi Computer Consulting, Inc., was my final choice for an editor. It is simple but adequate and uses little memory space. It lacked only a line-numbering capability, which I added as a modification.

I chose the TSC 8080 Mnemonic Assembler as the second member of the co-resident pair. It has every feature I want in an assembler. I used it without significant modification.

You will have to purchase these copyrighted programs from their respective vendors. The editor costs $12.50 from Scelbi, and the assembler costs $25 from TSC. Both include source listings. You also need the 8080 Relocator from TSC, priced at $8. A minimum of 20K of RAM is required. CONOPS, a console-based H8 operating system, is listed in the July 1979 issue of *Kilobaud* (p. 108).

Operation

First load CONOPS into the upper end of RAM and the H8 Console Driver into the low end. Control character processing by the console driver must be disabled by placing a RET instruction, (C9), in address 2144. The operating system I currently use is a refinement of CONOPS that incorporates the console driver and frees the memory block 2040–2163 for other use. Since the console driver is a Heath copyrighted program, I can't include a listing, but once you have your editor/assembler working, it is a simple matter to reassemble the driver if you wish to do so.

Before loading the editor, you must go through the Scelbi listing and change the

```
 BEGIN ADDRESS?  3100
   END ADDRESS?  356E
       MOVE TO?  2164

FIX REFERENCES        Y
LOAD FROM TAPE?       N
DATA BLOCKS?          N
ALTER RANGE?          N
FIX DW'S?             Y

ADDRESS?  3484  3487  348A  348D
          3490  3493  3496  3499
          349C  349F  34A2
```

Example 1.

address part of each instruction that references any of the mnemonic addresses in the following list. The correct address for each mnemonic is found in the symbol table of Listing 2.

STACK TBPTR PRINT INBF TXTBF LNUM TP1
TP3 TPLCT LOLOW HILOW RCV LPTB

Using the program loader of CONOPS, load the Scelbi Editor into RAM starting at 3100H. Since the source listing starts at 0100, you have to change the first zero of each address to 3. As you go along, you will find it easy to mentally add 30 to the last byte of each three-byte instruction. In general, this is what has to be done when loading any non-Heath program. Note that 30 must be added to the second byte of each command table DW. For example, the entry at 0484 (Scelbi listing) becomes DE32.

There is no change from the Scelbi listing until the WRITE routine at address 0299 in the book. At that point, you load the first segment of the modified program that is included with this article (Listing 1). Return to Scelbi at address 034F, the DELET routine. Depart the Scelbi listing at address 0483, CMDTB, and finish with the second segment of the modification (Listing 2). At this point, you have the complete, runable modified editor in RAM, from address 3100 to 356E.

Using the CONOPS GO command, jump to the editor START address, 34A5. The prompt, <, will be displayed on your terminal. The editor now has control and will function as described in the Scelbi manual.

The automatic memory sizing function, a part of the KILL subroutine, has been deleted. It is necessary, therefore, to ascertain that the LPTB address, 3568, contains the high byte of the text buffer upper limit. This value—initially 57—must be kept current with any change in the buffer size or location. For example, should you add more RAM, you would probably want to extend the text buffer.

The line-numbering feature is activated when the editor is started and can thereafter be turned off and on by typing N, followed by a carriage return. Line numbers are needed for programming but may be undesirable when outputting text to a printer. The line numbers use no text buffer memory space; only the current line number is stored.

Relocation

Check out the editor thoroughly. When you are satisfied that everything functions as intended, you can prepare to move it down to address block 2164-25D2. This will allow the TSC assembler to occupy block 25D8-3DF4. The text buffer, address 4000-57FF, is shared by the editor and assembler. This is an important feature of the co-resident arrangement.

A1	231A	A2	2329	ABUSS	2014	ADDM	3E00	APLNO	253F
APND	2317	ASSMB	3E5C	BASD	2585	BDCR	21D4	BDLN	2195
BFR	25C4	BXASD	2582	CCRLF	24E0	CDIN	2198	CHNGE	244A
CKOV	223B	CMDTB	24E7	CMP1	2238	CONT	23AB	CRC	02E7
CRCSUM	2017	CRLF	24E4	CTC	027A	D3	23C0	D4	23E6
D5	23F3	DECR	220A	DELET	23B3	DLET	23BC	DPCMP	222F
EDITOR	2509	EN1	228B	EN2	22AA	EN3	22BC	EN4	22BF
EREAD	252A	ERP	218F	ERR	218A	EXIT	25A5	FBFLM	2204
FD1	2265	FD2	2275	FHI	22A2	FIN	2549	FND	225F
FNUM	22E9	FOUND	2183	HDLN	221A	HILOW	3E09	IN2	21A6
INBF	3E0B	INCHR	6C1D	INCMD	2164	INCR	2215	INLNO	2553
INS1	23FC	INSRT	23F9	KILL	2530	LALL	2347	LHILO	2283
LISNO	255F	LIST	233D	LKCMD	2174	LNUM	4002	LOLOW	3E07
LOO	2591	LOOP1	25A3	LOOP2	25AE	LOOP3	25B2	LOP	239E
LP1	2511	LP2	251E	LP3	2525	LPTB	25CC	LRA	032A
LST	2353	LT2	235F	LT3	2371	MONIT	6EDB	MSG	2225
MWRITE	6E84	NC	24C3	NCHR	2242	NFLAG	23B2	NREST	23A8
NS2	2422	NS3	242F	NS3A	2432	NS4	243D	NSRT	2402
NUM	2577	NUM2	257D	NUMB	256E	OFL	2257	ONE	22E0
OPSYS	6C00	OVER	21FD	PRINT	25D0	RCHAR	2064	RCV	25CD
READ	01B1	RNB	02D9	RNP	02D5	RTN2	21CE	S1	246D
S3	24A1	S4	24D7	SCT	24D3	SDLT	23E3	SDLT1	23E1
SNST	2412	SP1	21A0	SRCH	2453	SRS1	02B5	STACK	4000
STAR	23A3	START	2000	SV	24CC	TAB	21E5	TBPTR	4000
TFT	025B	TOBN	22F4	TP1	3E02	TP3	3E04	TPABT	02A4
TPERR	0285	TPERRX	2019	TPLCT	3E05	TPXIT	02AA	TXTBF	4004
UNSPD	2397	WCHAR	2067	WNB	0314	WNP	030F	WRITE	22FD
ZLOK	227C								

Symbol table for the editor at its final location.

Relocation of the editor can be done quickly with the TSC relocator. It comes with source listing for 1000H, but two object code listings are provided. The one for placing the program at 4000H is ideal for relocating the editor.

Follow the instructions in the manual. Without the relocator, you will have to use the BLOCK MOVE command of CONOPS and then go through the relocated editor byte by byte, making the required address changes. A disassembler is useful at this point. Doing it the hard way will give you an appreciation for the TSC relocator, which is amazingly efficient.

Relocation will be complete and accurate if the TSC relocator prompts are responded to as shown in Example 1.

The editor tape routine dumps the entire text buffer to cassette in H8 memory image format. You can determine the address of the last byte of text by looking at the contents of addresses 4000 and 4001 (TBPTR). Addresses 4002 and 4003 (LNUM) contain the last line number in hex.

At this point, I suggest that you spend some time using the editor and learning its convenient features. It has many uses besides the preparation of programs for assembly.

More Modifications

Begin loading the assembler entry and control (Listing 3) from the source listing. The first byte, at 25D8, is also the entry address for the assembler. Continue to the end of the program, but be sure to observe the address change just past the EXIT statement at 2614.

Examine the program listing in the TSC manual. Since it begins at 1000 and we wish to start loading at 2600, the first two digits of each address must be increased by 16 hex. Since addition of hex numbers of this magnitude is difficult to do mentally, I found it useful to make up a little table for quick reference. You can skip the first two pages and begin loading at address 10C5 on page 3. Use the following code listing, which contains the special values needed to satisfy the requirements of a 20K system using CONOPS:

```
26C5 04 40
26C7 3F 41
26C9 00 58
26CB FF5F
26CD 00
26CE 00 60
26D0 3B
26D1 05
26D2 05
26D3 00 00
26D5 FF FF
26D7 C3 67 20
26DA C3 67 20
26DD C3 DB 6E
```

At address 10E0 (26E0), you can enter the program as printed. You must change the third byte of each three-byte instruction by

Listing 1. CONOPS modification for use with co-resident editor/assembler.

```
7000  STACK   EQU   $7000
2067  OUTCH   EQU   $2067
6EDB  MONIT   EQU   $6EDB
6C1D  INCHR   EQU   $6C1D
02A4  TPABT   EQU   $02A4
2019  TPERRX  EQU   $2019
025B  TFT     EQU   $025B
0285  TPERR   EQU   $0285
```

adding 16 hex. Be careful not to change any byte that is not the high part of an address. LXI instructions must be examined carefully, because some reference addresses and others do not. For example, 14EF 21 85 10, page 14, becomes 2AEF 21 85 26, because it refers to an address; 14FB 21 00 00 does not refer to an address so it is entered as 2AFB 21 00 00.

Each DW on page 4 must have 16 added to its second byte. For example, 1103 07 1B becomes 2703 07 31 (1B + 16 = 31 in hex). DB instructions are not changed. For example, 1131 41 07 is entered as 2731 41 07. The manual that comes with the TSC 8080 relocator has useful, relevant information. Beyond address 1486 (2A86) on page 13, there should be no problems if you are careful to check the LXIs.

Entering such a long program is a demanding task that is best to do in segments, working an hour or two at a time. Always save everything you enter on tape and do it frequently. I can recall a few unhappy events when power failures wiped out several hours of work.

The memory assignment for the coresident editor/assembler, for a 20K system, is shown in Table 1.

The assembler object code tape routine uses a special format that is compatible with the H8 tape system. To read the object code tape, you must use CONOPS GO command to jump to the RMEM routine at address 3D54. RMEM will place the code in memory at the locations specified by the ORG statements in the assembly-language source listing.

This technique is required when object code will occupy space that is used by the editor/assembler. If sufficient memory is available, you can use the MOVE CODE option at the end of PASS 3 to move code directly from the object code buffer to its final destination. If you ORG a program to 6004, you will be able to run it without relocation. This is useful for quickly testing programs under development. ■

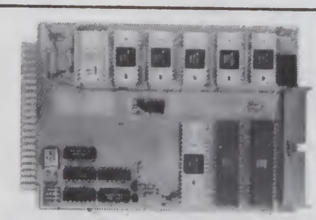
```
          02E7  CRC     EQU   $02E7
          02AA  TPXIT   EQU   $02AA
          032A  LRA     EQU   $032A
          2000  START   EQU   $2000
          2014  ABUSS   EQU   $2014
          2017  CRCSUM  EQU   $2017
          25D3  ASSEMB  EQU   $25D3
          2509  EDITOR  EQU   $2509
                *
                * READ OBJECT CODE TAPE PREPARED BY TSC 8080
                *  ASSEMBLER 'WRITE TAPE' COMMAND.
                *
6B60                    ORG   $6B60
                *
6B60 21 A4 02   TREAD   LXI   H,TPABT
6B63 22 19 20           SHLD  TPERRX
                *
6B66 01 00 FE   LOAD    LXI   B,$FE00
6B69 CD B7 6B   LOA0    CALL  SRS1
6B6C 6F                 MOV   L,A
6B6D EB                 XCHG
6B6E 0D                 DCR   C
6B6F 09                 DAD   B
6B70 7C                 MOV   A,H
6B71 C5                 PUSH  B
6B72 F5                 PUSH  PSW
6B73 E6 7F              ANI   $7F
6B75 B5                 ORA   L
6B76 3E 02              MVI   A,2
6B78 C2 85 02           JNZ   TPERR
6B7B CD DA 6B   LOA2    CALL  RNP
6B7E 44                 MOV   B,H
6B7F 4F                 MOV   C,A
6B80 3E 0A              MVI   A,10
6B82 D5                 PUSH  D
6B83 CD 2A 03           CALL  LRA
6B86 D1                 POP   D
6B87 71                 MOV   M,C
6B88 23                 INX   H
6B89 70                 MOV   M,B
                *
32B3 CD B6 31   APND    CALL  HDLN
32B6 CD DB 34   A1      CALL  APLNO
32B9 CD 34 31           CALL  CDIN
32BC CD D7 31           CALL  CKOV
32BF CD A0 31           CALL  FBFLM
32C2 2A 00 40           LHLD  TBPTR
32C5 1A         A2      LDAX  D
32C6 77                 MOV   M,A
32C7 13                 INX   D
32C8 23                 INX   H
32C9 A7                 ANA   A
32CA C2 C5 32           JNZ   A2
32CD 22 00 40           SHLD  TBPTR
32D0 21 02 40           LXI   H,LNUM
32D3 CD B1 31           CALL  INCR
32D6 C3 B6 32           JMP   A1
                *
32D9 0D         LIST    DCR   C
32DA CA E3 32           JZ    LALL
32DD CD 1F 32           CALL  LHILO
32E0 C3 EF 32           JMP   LST
                *
32E3 21 01 00   LALL    LXI   H,1
32E6 22 07 3E           SHLD  LOLOW
32E9 2A 02 40           LHLD  LNUM
32EC 22 09 3E           SHLD  HILOW
                *
32EF 2A 02 40   LST     LHLD  LNUM
32F2 11 00 00           LXI   D,0
32F5 CD CB 31           CALL  DPCMP
32F8 CA 26 31           JZ    ERR
                *
32FB CD B6 31   LT2     CALL  HDLN
32FE CD B6 31           CALL  HDLN
3301 CD FB 31           CALL  FND
3304 EB                 XCHG
                *
3305 E5                 PUSH  H
3306 2A 05 3E           LHLD  TPLCT
3309 22 00 3E           SHLD  ADDM
330C E1                 POP   H
330D 3A 4E 33   LT3     LDA   NFLAG
3310 B7                 ORA   A
3311 C4 FB 34           CNZ   LISNO
3314 CD C1 31           CALL  MSG
3317 23                 INX   H
3318 E5                 PUSH  H
3319 2A 07 3E           LHLD  LOLOW
331C EB                 XCHG
331D 2A 09 3E           LHLD  HILOW
3320 CD CB 31           CALL  DPCMP
3323 CA 00 31           JZ    INCMD
3326 21 07 3E           LXI   H,LOLOW
3329 CD B1 31           CALL  INCR
332C CD B6 31           CALL  HDLN
332F E1                 POP   H
6BFB 3E 01              MVI   A,1
6BFD C3 85 02           JMP   TPERR
                *
6F0F                    ORG   $6F0F
                *
                * EXTENSION TO CONOPS 'JUMP TABLE' FOR USE
                *  WITH CO-RESIDENT EDITOR/ASSEMBLER.
                *
6F0F FE 41              CPI   'A'
```

```
      6F11 CA D3 25          JZ     ASSEMB
      6F14 FE 45             CPI    'E'
      6F16 CA 09 25          JZ     EDITOR
      6F19 FE 54             CPI    'T'
      6F1B CA 60 6B          JZ     TREAD
      6F1E C3 DB 6E          JMP    MONIT
                      *
                             END

   0 ERROR(S) DETECTED

SYMBOL TABLE:

ABUSS  2014   ASSEMB 25D3   CRC    02E7   CRCSUM 2017   CTC    6BF2
EDITOR 2509   INCHR  6C1D   LOA0   6B69   LOA1   6B91   LOA2   6B7B
LOAD   6B66   LRA    032A   MONIT  6EDB   OUTCH  2067   RNB    6BE1
RNB1   6BE5   RNP    6BDA   SRS1   6BB7   SRS2   6BBB   STACK  7000
START  2000   TFT    025B   TPABT  02A4   TPERR  0285   TPERRX 2019
TPXIT  02AA   TREAD  6B60
```

Listing 2. Scelbi Editor and modifications.

```
               4000   TBPTR   EQU    $4000
               4000   STACK   EQU    TBPTR
               4002   LNUM    EQU    $4002
               4004   TXTBF   EQU    $4004
               6EDB   MONIT   EQU    $6EDB
               2064   RCHAR   EQU    $2064
               2067   OUTCH   EQU    $2067
               6C1D   INCHR   EQU    $6C1D
               6E84   MWRITE  EQU    $6E84
               2000   START   EQU    $2000
               2014   ABUSS   EQU    $2014
               01B1   READ    EQU    $01B1
               3100   INCMD   EQU    $3100
               31B6   HDLN    EQU    $31B6
               3134   CDIN    EQU    $3134
               31D7   CKOU    EQU    $31D7
               31A0   FBFLM   EQU    $31A0
               31B1   INCR    EQU    $31B1
               321F   LHILO   EQU    $321F
               31CB   DPCMP   EQU    $31CB
               3126   ERR     EQU    $3126
               31FB   FND     EQU    $31FB
               31C1   MSG     EQU    $31C1
               3218   ZLOK    EQU    $3218
               31A6   DECR    EQU    $31A6
               3199   OVER    EQU    $3199
               3142   IN2     EQU    $3142
               33E6   CHNGE   EQU    $33E6
               334F   DELET   EQU    $334F
               3395   INSRT   EQU    $3395
               33EF   SRCH    EQU    $33EF
                      *
                      *  SEGMENT ONE
                      *
      3299                    ORG    $3299
                      *
      3299 21 00 40   WRITE   LXI    H,TBPTR
      329C 22 00 20           SHLD   START
      329F 2A 00 40           LHLD   TBPTR
      32A2 22 14 20           SHLD   ABUSS
      32A5 CD 1D 6C           CALL   INCHR
      32A8 FE 20              CPI    '
      32AA C2 00 31           JNZ    INCMD
      32AD CD 84 6E           CALL   MWRITE
      32B0 C3 00 31           JMP    INCMD
      6B8A CD DA 6B           CALL   RNP
      6B8D 6F                 MOV    L,A
      6B8E 22 00 20           SHLD   START
      6B91 CD E1 6B   LOA1    CALL   RNB
      6B94 77                 MOV    M,A
      6B95 22 14 20           SHLD   ABUSS
      6B98 23                 INX    H
      6B99 1B                 DCX    D
      6B9A 7A                 MOV    A,D
      6B9B B3                 ORA    E
      6B9C C2 91 6B           JNZ    LOA1
      6B9F CD F2 6B           CALL   CTC
      6BA2 22 17 20           SHLD   CRCSUM
      6BA5 CD DA 6B           CALL   RNP
      6BA8 CD DA 6B           CALL   RNP
      6BAB 54                 MOV    D,H
      6BAC 5F                 MOV    E,A
      6BAD B2                 ORA    D
      6BAE C2 7B 6B           JNZ    LOA2
      6BB1 CD 5B 02           CALL   TFT
      6BB4 C3 DB 6E           JMP    MONIT
                      *
      6BB7 16 00      SRS1    MVI    D,0
      6BB9 62                 MOV    H,D
      6BBA 6A                 MOV    L,D
      6BBB CD E1 6B   SRS2    CALL   RNB
      6BBE 14                 INR    D
      6BBF FE 16              CPI    $16
      6BC1 CA BB 6B           JZ     SRS2
      6BC4 FE 02              CPI    2
      6BC6 C2 B7 6B           JNZ    SRS1
      6BC9 3E 0A              MVI    A,10
      6BCB BA                 CMP    D
      6BCC D2 B7 6B           JNC    SRS1
      6BCF 22 17 20           SHLD   CRCSUM
      6BD2 CD DA 6B           CALL   RNP
      6BD5 54                 MOV    D,H
```

```
6BD6 5F                 MOV    E,A
6BD7 C3 DA 6B           JMP    RNP
                *
6BDA CD E1 6B   RNP     CALL   RNB
6BDD 67                 MOV    H,A
6BDE C3 E1 6B           JMP    RNB
                *
6BE1 3E 34      RNB     MVI    A,$34
6BE3 D3 F9              OUT    $F9
6BE5 CD AA 02   RNB1    CALL   TPXIT
6BE8 E6 02              ANI    2
6BEA CA E5 6B           JZ     RNB1
6BED DB F8              IN     $F8
6BEF C3 E7 02           JMP    CRC
                *
6BF2 CD DA 6B   CTC     CALL   RNP
6BF5 2A 17 20           LHLD   CRCSUM
6BF8 7C                 MOV    A,H
6BF9 B5                 ORA    L
6BFA C8                 RZ
3330 C3 0D 33           JMP    LT3
                *
3333 C5         UNSPD   PUSH   B
3334 AF                 XRA    A
3335 0E 11              MVI    C,11H
3337 C3 3F 33           JMP    STAR
333A 90         LOP     SUB    B
333B F2 44 33           JP     NREST
333E 80                 ADD    B
333F 29         STAR    DAD    H
3340 17                 RAL
3341 C3 47 33           JMP    CONT
3344 29         NREST   DAD    H
3345 17                 RAL
3346 23                 INX    H
3347 0D         CONT    DCR    C
3348 C2 3A 33           JNZ    LOP
334B 1F                 RAR
334C C1                 POP    B
334D C9                 RET
                *
334E 00         NFLAG   DB     0
                *
                *  SEGMENT TWO
                *
3483                    ORG    $3483
                *
3483 41         CMDTB   DB     'A'
3484 B3 32              DW     APND
3486 43                 DB     'C'
3487 E6 33              DW     CHNGE
3489 44                 DB     'D'
348A 4F 33              DW     DELET
348C 49                 DB     'I'
348D 95 33              DW     INSRT
348F 4B                 DB     'K'
3490 CC 34              DW     KILL
3492 4C                 DB     'L'
3493 D9 32              DW     LIST
3495 4E                 DB     'N'
3496 0A 35              DW     NUMB
3498 52                 DB     'R'
3499 C6 34              DW     EREAD
349B 53                 DB     'S'
349C EF 33              DW     SRCH
349E 57                 DB     'W'
349F 99 32              DW     WRITE
34A1 45                 DB     'E'
34A2 41 35              DW     EXIT
                *
34A4 00                 DB     0
                *
34A5 3E FF      EDITOR  MVI    A,-1
34A7 32 4E 33           STA    NFLAG
34AA 21 04 40           LXI    H,TXTBF
34AD 7E         LP1     MOV    A,M
34AE FE 00              CPI    0
34B0 C2 BA 34           JNZ    LP2
34B3 23                 INX    H
34B4 7E                 MOV    A,M
34B5 FE 00              CPI    0
34B7 CA 00 31           JZ     INCMD
34BA FE 0D      LP2     CPI    $D
34BC C2 C1 34           JNZ    LP3
34BF AF                 XRA    A
34C0 77                 MOV    M,A
34C1 23         LP3     INX    H
34C2 C3 AD 34           JMP    LP1
34C5 00                 DB     0
                *
34C6 CD B1 01   EREAD   CALL   READ
34C9 C3 00 31           JMP    INCMD
                *
34CC 21 04 40   KILL    LXI    H,TXTBF
34CF 22 00 40           SHLD   TBPTR
34D2 21 00 00           LXI    H,0
34D5 22 02 40           SHLD   LNUM
34D8 C3 00 31           JMP    INCMD
                *
34DB E5         APLNO   PUSH   H
34DC D5                 PUSH   D
34DD F5                 PUSH   PSW
34DE CD B6 31           CALL   HDLN
34E1 2A 02 40           LHLD   LNUM
34E4 23                 INX    H
34E5 22 00 3E   FIN     SHLD   ADDM
```




```
34E8 CD 1E 35              CALL   BXASD
34EB F1                    POP    PSW
34EC D1                    POP    D
34ED E1                    POP    H
34EE C9                    RET
                    *
34EF E5             INLNO  PUSH   H
34F0 D5                    PUSH   D
34F1 F5                    PUSH   PSW
34F2 CD B6 31              CALL   HDLN
34F5 2A 07 3E              LHLD   LOLOW
34F8 C3 E5 34              JMP    FIN
                    *
34FB E5             LISNO  PUSH   H
34FC D5                    PUSH   D
34FD CD 1E 35              CALL   BXASD
3500 2A 00 3E              LHLD   ADDM
3503 23                    INX    H
3504 22 00 3E              SHLD   ADDM
3507 D1                    POP    D
3508 E1                    POP    H
3509 C9                    RET
                    *
350A 3A 4E 33       NUMB   LDA    NFLAG
350D B7                    ORA    A
350E C2 19 35              JNZ    NUM2
3511 3E FF                 MVI    A,-1
3513 32 4E 33       NUM    STA    NFLAG
3516 C3 00 31              JMP    INCMD
3519 3E 00          NUM2   MVI    A,0
351B C3 13 35              JMP    NUM
                    *
351E 2A 00 3E       BXASD  LHLD   ADDM
3521 11 60 35       BASD   LXI    D,BFR
3524 13                    INX    D
3525 13                    INX    D
3526 13                    INX    D
3527 13                    INX    D
3528 D5                    PUSH   D
3529 0E 05                 MVI    C,$5
352B 06 0A                 MVI    B,$A
352D CD 33 33       LOO    CALL   UNSPD
3530 C6 30                 ADI    $30
3532 12                    STAX   D
3533 1B                    DCX    D
3534 0D                    DCR    C
3535 C2 2D 35              JNZ    LOO
3538 D1                    POP    D
3539 13                    INX    D
353A 21 61 35              LXI    H,BFR+1
353D CD C1 31              CALL   MSG
3540 C9                    RET
                    *
3541 21 04 40       EXIT   LXI    H,TXTBF
3544 7E             LOOP1  MOV    A,M
3545 FE 00                 CPI    0
3547 CA 4E 35              JZ     LOOP3
354A 23             LOOP2  INX    H
354B C3 44 35              JMP    LOOP1
354E 3E 0D          LOOP3  MVI    A,$D
3550 77                    MOV    M,A
3551 23                    INX    H
3552 7E                    MOV    A,M
3553 FE 00                 CPI    0
3555 C2 4A 35              JNZ    LOOP2
3558 2A 00 40              LHLD   TBPTR
355B AF                    XRA    A
355C 77                    MOV    M,A
355D C3 DB 6E              JMP    MONIT
                    *
3560                BFR    DS     5
3565 20 20 00              DB     $20,$20,0
3568 57             LPTB   DB     $57
                    *
3569 CD 64 20       RCV    CALL   RCHAR
356C C3 67 20       PRINT  JMP    OUTCH
                    *
3E00                       ORG    $3E00
                    *
3E00 00 00          ADDM   DW     0
3E02 00 00          TP1    DW     0
3E04 00             TP3    DB     0
3E05 00 00          TPLCT  DW     0
3E07 00 00          LOLOW  DW     0
3E09 00 00          HILOW  DW     0
                    *
3E0B                INBF   DS     $51
                    *
3E5C 00             ASSMB  DB     0
                    *
                           END

    0 ERROR(S) DETECTED
SYMBOL TABLE:

A1     32B6   A2     32C5   ABUSS  2014   ADDM   3E00   APLNO  34DB
APND   32B3   ASSMB  3E5C   BASD   3521   BFR    3560   BXASD  351E
CDIN   3134   CHNGE  33E6   CKOV   31D7   CMDTB  3483   CONT   3347
DECR   31A6   DELET  334F   DPCMP  31CB   EDITOR 34A5   EREAD  34C6
ERR    3126   EXIT   3541   FBFLM  31A0   FIN    34E5   FND    31FB
HDLN   31B6   HILOW  3E09   IN2    3142   INBF   3E0B   INCHR  6C1D
INCMD  3100   INCR   31B1   INLNO  34EF   INSRT  3395   KILL   34CC
LALL   32E3   LHILO  321F   LISNO  34FB   LIST   32D9   LNUM   4002
LOLOW  3E07   LOO    352D   LOOP1  3544   LOOP2  354A   LOOP3  354E
LOP    333A   LP1    34AD   LP2    34BA   LP3    34C1   LPTB   3568
```

```
LST     32EF   LT2     32FB   LT3     330D   MONIT   6EDB   MSG     31C1
MWRITE  6E84   NFLAG   334E   NREST   3344   NUM     3513   NUM2    3519
NUMB    350A   OUTCH   2067   OVER    3199   PRINT   356C   RCHAR   2064
RCV     3569   READ    01B1   SRCH    33EF   STACK   4000   STAR    333F
START   2000   TBPTR   4000   TP1     3E02   TP3     3E04   TPLCT   3E05
TXTBF   4004   UNSPD   3333   WRITE   3299   ZLOK    3218
```

Listing 3. TSC's assembler entry and control.

```
                4000   TBPTR   EQU    $4000
                4000   STACK   EQU    TBPTR
                26C7   SRCEND  EQU    $26C7
                2A86   P1INIT  EQU    $2A86
                2B02   PASS1   EQU    $2B02
                2B2F   P2INIT  EQU    $2B2F
                2B6F   PASS2   EQU    $2B6F
                26B4   OPTMEM  EQU    $26B4
                26B0   OPTSYM  EQU    $26B0
                26B2   OPTLST  EQU    $26B2
                2064   RCHAR   EQU    $2064
                2DE1   PSTRG   EQU    $2DE1
                2000   START   EQU    $2000
                2008   MFLAG   EQU    $2008
                2014   ABUSS   EQU    $2014
                26CE   MEMORY  EQU    $26CE
                0260   HORN    EQU    $0260
                2019   TPERRX  EQU    $2019
                0314   WNB     EQU    $0314
                2017   CRCSUM  EQU    $2017
                030F   WNP     EQU    $030F
                6C00   CONOPS  EQU    $6C00
                02A4   TPABT   EQU    $02A4
                025B   TFT     EQU    $025B
                2067   OUTCH   EQU    $2067
                6EDB   MONIT   EQU    $6EDB
                6C1D   INCHR   EQU    $6C1D
                       *
25D3                           ORG    $25D3
                       *
25D3 31 00 40          ASSEMB  LXI    SP,STACK
25D6 3E 80                     MVI    A,$80        ;DISABLE 'HLT'
25D8 32 08 20                  STA    MFLAG        ;PROCESSING
                       *
25DB 2A 00 40          INITL   LHLD   TBPTR        ;GET TEXT BUFR PNTR
25DE 2B                        DCX    H
25DF 22 C7 26                  SHLD   SRCEND       ;ADDR OF LAST SOURCE CHAR
                       *
25E2 21 70 3C          CNTRL   LXI    H,MSG1
25E5 CD E1 2D                  CALL   PSTRG
25E8 CD 1D 6C                  CALL   INCHR
25EB FE 32                     CPI    '2'
25ED C2 91 3C                  JNZ    PS3
25F0 CD 86 2A                  CALL   P1INIT
25F3 CD 02 2B                  CALL   PASS1
25F6 CD 2F 2B                  CALL   P2INIT
25F9 CD 6F 2B                  CALL   PASS2
25FC 3A B4 26                  LDA    OPTMEM       ;CHECK MEMORY OPTION FLAG
25FF B7                        ORA    A
2600 CA 14 26                  JZ     EXIT         ;IF OPTMEM CLEARED
                       *
2603 21 78 3C          CODE    LXI    H,MSG2
2606 CD E1 2D                  CALL   PSTRG
2609 CD 1D 6C                  CALL   INCHR
260C FE 59                     CPI    'Y'
260E C2 14 26                  JNZ    EXIT
2611 CD C7 3C                  CALL   CODMOV
                       *
2614 C3 DB 6E          EXIT    JMP    MONIT
                       *
3C70                           ORG    $3C70
                       *
3C70 50 41 53          MSG1    DB     'PASS = ',4
3C73 53 20 3D
3C76 20 04
3C78 4D 4F 56          MSG2    DB     'MOVE CODE? ',4
3C7B 45 20 43
3C7E 4F 44 45
3C81 3F 20 04
3C84 57 52 49          MSG3    DB     'WRITE TAPE? ',4
3C87 54 45 20
3C8A 54 41 50
3C8D 45 3F 20
3C90 04
                       *
3C91 FE 33             PS3     CPI    '3'
3C93 C2 14 26                  JNZ    EXIT
3C96 CD 86 2A                  CALL   P1INIT
3C99 3E FF                     MVI    A,-1
3C9B 32 B4 26                  STA    OPTMEM
3C9E AF                        XRA    A
3C9F 32 B0 26                  STA    OPTSYM
3CA2 32 B2 26                  STA    OPTLST
3CA5 CD 02 2B                  CALL   PASS1
3CA8 CD 2F 2B                  CALL   P2INIT
3CAB CD 6F 2B                  CALL   PASS2
3CAE 21 84 3C                  LXI    H,MSG3
3CB1 CD E1 2D                  CALL   PSTRG
3CB4 CD 1D 6C                  CALL   INCHR
3CB7 FE 59                     CPI    'Y'
3CB9 C2 03 26                  JNZ    CODE
3CBC CD 1D 6C                  CALL   INCHR
3CBF FE 20                     CPI    ' '          ;SPACE WILL START TAPE WRITE
3CC1 C2 14 26                  JNZ    EXIT
3CC4 C3 E2 3C                  JMP    WMEM         ;WRITE TAPE
                       *
```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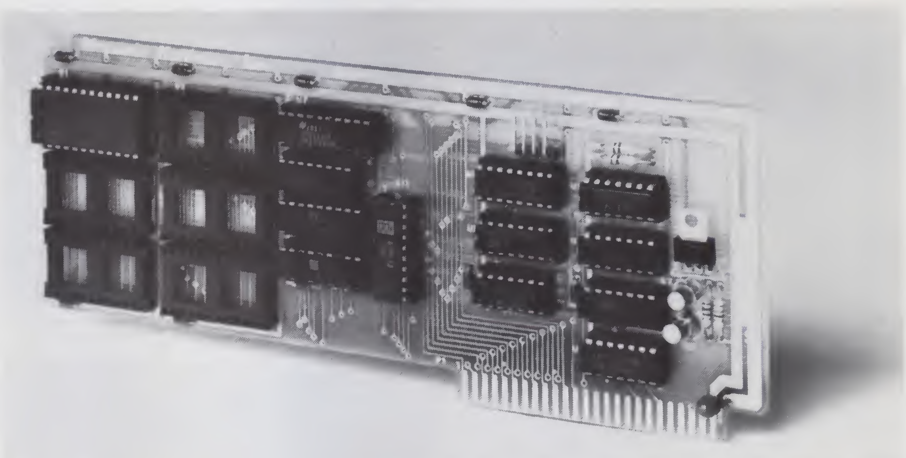
```
3CC7 2A CE 26   CODMOV  LHLD   MEMORY     ;ADDR OF MEMORY CODE STORE
3CCA 4E         LOOP1   MOV    C,M
3CCB 23                 INX    H
3CCC 46                 MOV    B,M
3CCD 23                 INX    H
3CCE 5E                 MOV    E,M
3CCF 23                 INX    H
3CD0 56                 MOV    D,M
3CD1 23                 INX    H
3CD2 78                 MOV    A,B
3CD3 B1                 ORA    C
3CD4 C8                 RZ
3CD5 7E         LOOP2   MOV    A,M
3CD6 12                 STAX   D
3CD7 23                 INX    H
3CD8 13                 INX    D
3CD9 0B                 DCX    B
3CDA 78                 MOV    A,B
3CDB B1                 ORA    C
3CDC C2 D5 3C           JNZ    LOOP2
3CDF C3 CA 3C           JMP    LOOP1
                *
                * DUMP - DUMP MEMORY TO CASSETTE
                *
3CE2 21 A4 02   WMEM    LXI    H,TPABT
3CE5 22 19 20           SHLD   TPERRX     ;SET UP ERROR EXIT
3CE8 3E 01      DUMP    MVI    A,1
3CEA D3 F9              OUT    $F9        ;ENABLE TRANSMITTER
3CEC 3E 16              MVI    A,$16      ;SYN CHAR
3CEE 26 20              MVI    H,$20      ;(H) = # OF SYN CHARS.
3CF0 CD 14 03   WME1    CALL   WNB        ;WRITE NEXT BYTE
3CF3 25                 DCR    H
3CF4 C2 F0 3C           JNZ    WME1       ;WRITE SYN HEADER
3CF7 3E 02              MVI    A,2        ;STX CHAR. INDICATES START OF
RECORD
3CF9 CD 14 03           CALL   WNB        ;WRITE STX
3CFC 6C                 MOV    L,H        ;(HL) = 00
3CFD 22 17 20           SHLD   CRCSUM     ;CLEAR CRC 16
3D00 21 01 81           LXI    H,$8101    ;TYPE AND RECORD BYTES
3D03 CD 0F 03           CALL   WNP        ;WRITE 2 BYTES TO TAPE
3D06 2A CE 26           LHLD   MEMORY     ;GET MBUFF ADDR
3D09 CD 43 3D           CALL   CHKCNT     ;RET WITH (DE) = COUNT
3D0C EB         WME3    XCHG              ;(HL) = COUNT
3D0D E5                 PUSH   H
3D0E D5                 PUSH   D
3D0F CD 0F 03           CALL   WNP        ;WRITE COUNT TO TAPE
3D12 21 00 6C           LXI    H,CONOPS
3D15 CD 0F 03           CALL   WNP        ;WRITE ENTRY ADDR
3D18 E1                 POP    H          ;GET ADDR NEXT WORD IN MBUFF
3D19 5E                 MOV    E,M        ;GET DESTINATION ADDR
3D1A 23                 INX    H          ;FOR 1 ST DATA BYTE
3D1B 56                 MOV    D,M
3D1C 23                 INX    H
3D1D E5                 PUSH   H          ;SAVE NEXT MBUF ADDR
3D1E EB                 XCHG              ;(HL) = DEST ADDR
3D1F CD 0F 03           CALL   WNP        ;WRITE DEST ADDR TO TAPE
3D22 E1                 POP    H          ;GET MBUFF ADDR
3D23 D1                 POP    D          ;GET COUNT
3D24 7E         WME2    MOV    A,M        ;GET DATA BYTE
3D25 CD 14 03           CALL   WNB        ;WRITE DATA BYTE
3D28 22 14 20           SHLD   ABUSS      ;SET ADDR FOR DISPLAY
3D2B 23                 INX    H
3D2C 1B                 DCX    D
3D2D 7A                 MOV    A,D
3D2E B3                 ORA    E          ;END OF RECORD TEST
3D2F C2 24 3D           JNZ    WME2       ;IF MORE TO GO
3D32 E5                 PUSH   H
                *
                * WRITE CHECKSUM TO TAPE
                *
3D33 2A 17 20           LHLD   CRCSUM
3D36 CD 0F 03           CALL   WNP        ;WRITE IT
3D39 CD 0F 03           CALL   WNP        ;FLUSH CHECKSUM
3D3C E1                 POP    H
3D3D CD 43 3D           CALL   CHKCNT     ;EXIT IF NO MORE RECORDS
3D40 C3 0C 3D           JMP    WME3
                *
                *
3D43 5E         CHKCNT  MOV    E,M
3D44 23                 INX    H
3D45 56                 MOV    D,M
3D46 23                 INX    H
3D47 7A                 MOV    A,D        ;CHECK FOR 0000 BYTES
3D48 B3                 ORA    E          ;WHICH MEANS FINAL RECORD
3D49 C0                 RNZ
3D4A EB                 XCHG              ;(HL)= ZERO
3D4B CD 0F 03           CALL   WNP        ;WRITE 0000 TO TAPE
3D4E CD 5B 02           CALL   TFT        ;TAPE OFF, SOUND HORN
3D51 C3 DB 6E           JMP    MONIT
                *
                        END

    0 ERROR(S) DETECTED
SYMBOL TABLE:

ABUSS   2014   ASSEMB 25D3   CHKCNT 3D43   CNTRL  25E2   CODE   2603
CODMOV  3CC7   CONOPS 6C00   CRCSUM 2017   DUMP   3CE8   EXIT   2614
HORN    0260   INCHR  6C1D   INITL  25DB   LOOP1  3CCA   LOOP2  3CD5
MEMORY  26CE   MFLAG  2008   MONIT  6EDB   MSG1   3C70   MSG2   3C78
MSG3    3C84   OPTLST 26B2   OPTMEM 26B4   OPTSYM 26B0   OUTCH  2067
P1INIT  2A86   P2INIT 2B2F   PASS1  2B02   PASS2  2B6F   PS3    3C91
PSTRG   2DE1   RCHAR  2064   SRCEND 26C7   STACK  4000   START  2000
TBPTR   4000   TFT    025B   TPABT  02A4   TPERRX 2019   WME1   3CF0
WME2    3D24   WME3   3D0C   WMEM   3CE2   WNB    0314   WNP    030F
```

Romplus +

ROM expansion for the Apple II.

Jeffrey G. Mazur
8041 Sadring
Canoga Park, CA 91304



The Romplus + Apple memory expansion board.

Mountain Computer's (formerly Mountain Hardware) Romplus + could be a welcome addition to your Apple II computer.

The board allows up to 12K of ROM or EPROM to be easily added. The board also includes a control ROM and 255 bytes of RAM to simplify its use. It even has a couple of TTL inputs that can be tested for special control functions.

These items alone would justify the modest price of the Romplus +. But also, 2K ROM included in one of the sockets contains a program called the Keyboard Filter. Written by Randy Hertzfeld, the Keyboard Filter can add upper/lowercase, multiple character fonts, colored letters, keyboard macros and improved cursor control and editing.

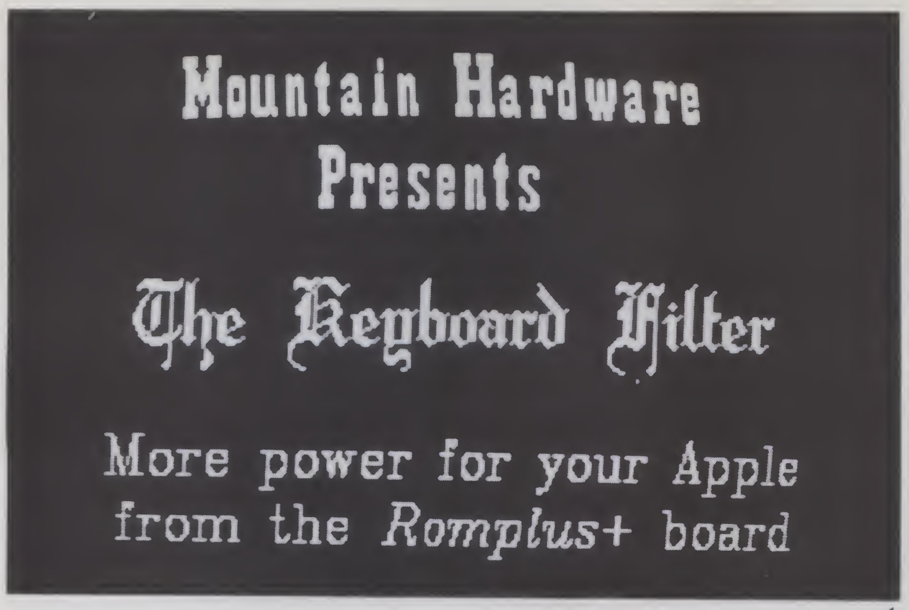
The Hardware

The Romplus + is easy to use. First, you initialize the board by the usual PR# command from BASIC. Then, you can activate a particular program by typing a CTRL-SHIFT-M or CTRL-SHIFT-N and a two-character code.

This code consists of a number from 0 to 6 to specify which chip and a letter to identify a particular program on that chip. For instance, CTRL-SHIFT-M 1A is the command to invoke the Keyboard Filter. The selected ROM then occupies the C800–C8FF mem-

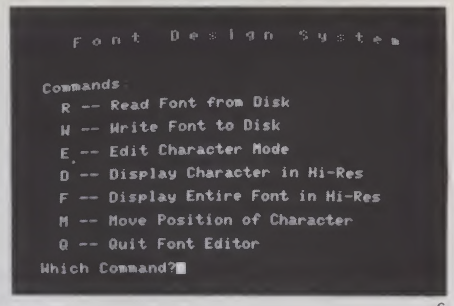
A:	Not used by Keyboard Filter
B:	Not used by Keyboard Filter
C:	Normal usage—stops programs
D:	Used by DOS
E:	Turns on CURSOR MOVEMENT MODE
F:	FONT SWITCHING character—follow with number of desired font (0 = font on Keyboard Filter ROM)
G:	Normal usage—rings bell
H:	Normal usage—back space
I:	Toggles INVERSE MODE
J:	Not used by Keyboard Filter
K:	Used to select INPUT FROM PERIPHERALS. Follow with slot number of peripheral desired.
L:	Toggles SHIFT LOCK mode
M:	Normal usage—carriage return
N:	Not used by Keyboard Filter
O:	Toggles OVERSTRIKE MODE
P:	SWITCHES PAGE being displayed
Q:	Diverts OUTPUT to printer, etc. Follow with slot number of output device.
R:	Toggles RAW MODE
S:	Prints a KEYBOARD MACRO. Follow with key for desired macro. Also used for *STOPLIST* & *ENDLIST*.
T:	Switches COLOR of characters. Follow with number of desired color (0-4)
U:	Not used by Keyboard Filter
V:	Toggles normal SHIFT KEY USAGE in modified Apples
W:	COPY TO END OF LINE
X:	Normal usage—terminates current line
Y:	Not used by Keyboard Filter
Z:	CLEARS currently displayed PAGE. From within program use CALL -13376 (must be last command on line).

Table 1. Keyboard Filter commands (invoked with CTRL key).



1.

Photos 1–5. Scenes from the Keyboard Filter and Quick Tour.



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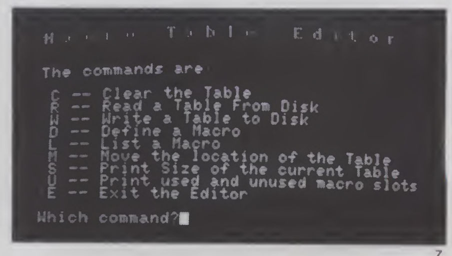
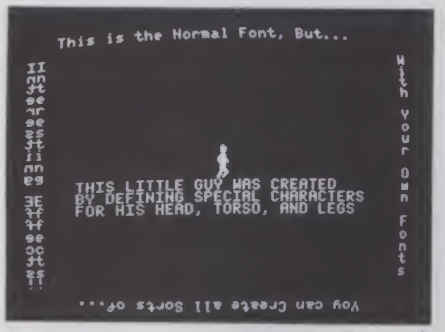


7.

Photos 6–7. Programs to create and edit character fonts and keyboard macros.



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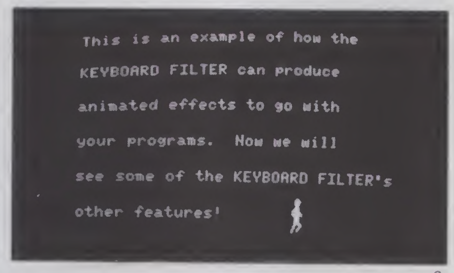

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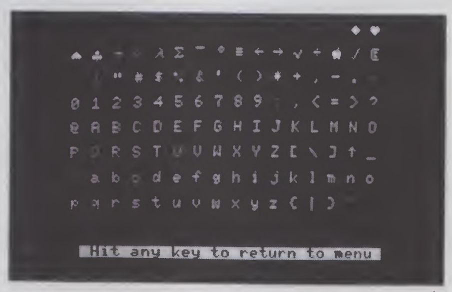

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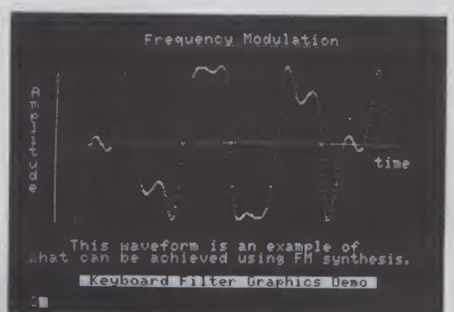

5.

```
10000 PRINT "";: REM CTRL O
10001 L = LEN (A$): FOR I = 1 TO L: PRINT CHR$
      (95);: NEXT : FOR I = 1 TO L: PRINT CHR$
      (08);: NEXT : PRINT A$;
10002 PRINT "";: REM CTRL O
10003 RETURN
```

Listing 1. This short subroutine can be embedded within a PRINT statement to print and underline text stored in A$.

ory space allocated for Apple ROM expansion.

Normally, the last 256 bytes of ROM will be replaced by the onboard RAM. This gives some scratch pad area without interfering with Apple's RAM. If the full 2K ROM space is needed, the scratch pad RAM can be disabled. The last address, C8FF, is reserved for disabling the ROM expansion. You can inspect or change status of the Romplus + through a control word; this includes ROM selection, TTL-input testing and onboard RAM enable/disable.

The documentation supplied with the Romplus + gives complete operating instructions and information on how to program your own PROM. For programs that are too large to fit on a single 2K ROM, a short subroutine shows how to continue programs on more than one chip.

The Software

The Keyboard Filter does more for Apple than any other utility program I've seen. All functions are accessed through single-control character commands. Table 1 lists all of the new commands available with the Filter. Most commands can be included within program PRINT statements. This is done while in the RAW mode, where the control characters are processed normally by the Apple rather than executed immediately by the Filter. Keyboard macros allow entries up to 63 characters long to be entered with just three keystrokes.

The demo disk that accompanies the Keyboard Filter contains a program called Quick Tour, which takes you through all of its functions. The accompanying photos show some of these capabilities. The disk also includes programs to create new character fonts and keyboard macros.

The overstrike mode is another feature of the Keyboard Filter. It allows two or more characters to be displayed on top of each other. A simple subroutine such as Listing 1 can be used within your programs to print a string A$ with an underline.

If you already have a hardware lowercase modification on your Apple, the Keyboard Filter will work even better with it. Also, the manual shows how to add a single wire from the Romplus + to the Apple keyboard that will allow the shift key to function just like on a typewriter.

All in all, the Romplus + and the Keyboard Filter add a lot of features at a reasonable price. It is available from Mountain Computer Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060, for $169. ■

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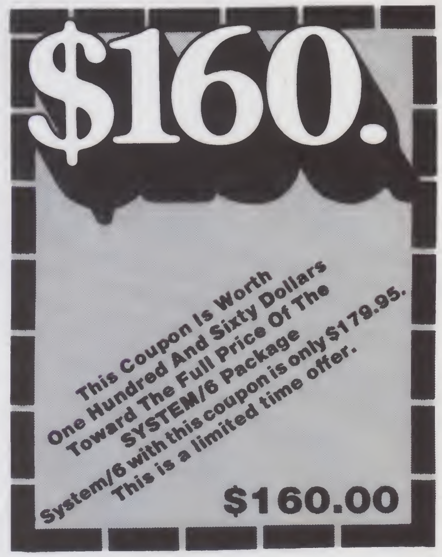

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Assembly Language Using Level II ROM Subroutines

It's not difficult to master.

After you have recovered from the shock of learning the fundamentals of assembly-language programming, it is ridiculous for you to "reinvent the wheel" by writing dozens of lines or pages of source code to perform simple single- and double-precision arithmetic calculations when these routines already exist in Level II ROM and may be accessed with a single call.

Assembly-language programming, with its resulting source code programs running over 300 times faster than BASIC and requiring, on the average, only 1/10th as much memory to perform the same functions as BASIC, is really the ne plus ultra for the serious amateur programmer who wishes to advance beyond the inherent limitations of BASIC, FORTRAN, COBOL, Pascal or any of the high-level computer languages.

Prior to the "unlocking" of the ROM routines, would-be assembly-language programmers were forced to learn by rote those assembly-language subroutines for all the functions that were already extant in the Level II ROM because no one had ever figured out exactly how to access all these subroutines—i.e., break the beautifully encrypted Level II code written by Microsoft's Paul Allen and Bill Gates.

The Level II ROM code has now been broken. For some reason, neither Radio Shack nor Microsoft has come forward to tell the 200,000+ TRS-80 users how to use the myriad Level II ROM subroutines in assembly-language programs.

This point is best illustrated by Radio Shack's book, *TRS-80 Assembly Language Programming*, introduced in mid-1979, which introduces the would-be assembly-language programmer to T-BUG but then switches to multi-line demonstration programs covering keyboard scan, video display, fill, move, muladd, mulsub, compare, mul16, div16. All of these could have been accomplished with only a few lines of

Listing 1. Integer arithmetic source code.

```
;       USING LEVEL II ROM SUBROUTINES    + - * /

W4UCH   EQU     7D00H           ;= 32000 DECIMAL
        ORG     W4UCH           ;PROGRAM WILL START HERE
BEGIN   LD      A,4FH           ;"O" OPERATION DESIRED
        CALL    032AH           ;DISPLAY "O" ON VIDEO
        LD      A,3FH           ;= ASCII ?
        CALL    032AH           ;DO IT - ON VIDEO
        LD      A,20H           ;= ASCII SPACE
        CALL    032AH           ;DO IT - ON VIDEO
        CALL    049H            ;KYBD INPUT + - * /
        CALL    032AH           ;DISPLAY FUNCTION
        LD      (FUNCT),A       ;STASH DESIRED OPERATION
        LD      A,0DH           ;0DH = SKIP A LINE
        CALL    032AH           ;DO IT - ON VIDEO
        LD      A,46H           ;"F" = FIRST NUMBER
        CALL    032AH           ;DO IT - ON VIDEO
        CALL    1BB3H           ;KYBD/VIDEO INPUT ROUTINE
        RST     10H             ;SCAN $ SET "C" FLAG
        CALL    0E6CH           ;ASCII-ACCUM RET MIN
        CALL    0A7FH           ;CONVERT TO INTEGER
        PUSH    HL              ;SAVE INTEGER IN STACK
        LD      A,53H           ;"S" = 2ND NUMBER
        CALL    032AH           ;DISPLAY "S" ON VIDEO
        CALL    1BB3H           ;KYBD/VIDEO INPUT ROUTINE
        RST     10H             ;SCAN $ SET "C" FLAG
        CALL    0E6CH           ;ASCII$ TO ACCUM RET MIN
        CALL    0A7FH           ;CONVERT TO INTEGER
        POP     DE              ;PREVIOUS HL TO DE REG
        LD      A,(FUNCT)       ;RECALL + - * / FROM MEM
        CP      2BH             ;IS IT + ?
        JR      Z,ADD           ;IF SO GOTO ADD
        CP      2DH             ;IS IT - ?
        JR      Z,SUB           ;IF SO GOTO SUBTRACT
        CP      2AH             ;IS IT * ?
        JR      Z,MULT          ;IF SO GOTO MULTIPLY
        CP      2FH             ;IS IT / ?
        JR      Z,DIVIDE        ;IF SO GOTO DIVIDE
VIDEO   LD      A,3DH           ;3DH IS ASCII = SIGN
        CALL    032AH           ;DO IT - ON VIDEO
        LD      A,20H           ;= ASCII SPACE
        CALL    032AH           ;DO IT - ON VIDEO
        CALL    0FBDH           ;CONV ACCUM TO STRING
        CALL    28A7H           ;DISPLAY STRING ON VIDEO
        LD      A,0DH           ;= SKIP A LINE
        CALL    032AH           ;DO IT - ON VIDEO
        JR      BEGIN           ;REPEAT ROUTINE
ADD     CALL    0BD2H           ;ADD DE + HL
        JR      VIDEO           ;OUTPUT RESULT
SUB     CALL    0BC7H           ;SUBTRACT DE - HL
        JR      VIDEO           ;OUTPUT RESULT
MULT    CALL    0BF2H           ;MULTIPLY DE * HL
        JR      VIDEO           ;OUTPUT RESULT
DIVIDE  CALL    2490H           ;DIVIDE DE / HL
        JR      VIDEO           ;OUTPUT RESULT
FUNCT   DEFB                    ;SAVE BYTE-STASH FUNCTION
        END     W4UCH           ;AMATEUR RADIO CALL LTRS
```

assembly-language programming if the extant Level II ROM subroutines had been used.

If you have mastered Level II BASIC, you should have great fun with this totally new approach to assembly-language programming. By mastering Level II BASIC, you have demonstrated the skills and persistence necessary to become an advanced assembly-language programmer with only a few weeks of study rather than what heretofore took many months or years.

The reputed "experts" in the field of assembly-language programming have created an aura and mystique about the subject which is totally undeserved and seeks only to promote their own self-esteem. Let us take a brief look at how simple assembly-language programming can be by illustrating our point with a few simple arithmetic programs that almost exclusively use Level II ROM subroutines.

Fundamentals of Level II ROM Arithmetic

ROM arithmetic subroutines are identical to those you would have to write for integers, single precision, double precision, addition, subtraction, multiplication, division, as well as all the trigonometric, exponential and log functions, were they not now available to the assembly-language programmer. It is true for all Level II ROM functions which are nothing more than binary bytes we may manipulate as long as we know where they are located.

Since you can't write to a ROM, Level II uses the RAM memory from 14302 to 17129 for all its housekeeping chores. The keyboard from 14336 to 15360 is not really RAM at all, but a simple key/switch matrix that the rest of the system thinks is RAM. Video memory occupies memory locations 15360 to 16383. Except for memory locations 14302 to 14336, all the non-disk Level II RAM housekeeping chores are done between 16384 and 17129.

Three RAM memory locations are of particular interest while discussing arithmetic + − * / subroutines: the ACCUMulator, CDBL store (as in storage) and NT (number type). Arithmetic numbers stashed in RAM use the following conventions: integers occur with the LSB (least significant byte) first and MSB (most significant byte) second using two's complement format, and single- and double-precision numbers use normalized exponential format with 128 added to the exponent (the high bit of the MSB) reflecting the + or − sign of the number. Do not concern yourself with these number formats, since our Level II ROM will handle all the conversions necessary if we use them properly.

The ACCUM occupies memory locations 411DH through 4124H (eight bytes), and CDBL store occupies 4127H through

Listing 2. Integer arithmetic object code.

```
7D00          00140 W4UCH   EQU    7D00H
7D00          00150         ORG    W4UCH          00100 ;
7D00 3E4F     00160 BEGIN   LD     A,4FH          00110
7D02 CD2A03   00170         CALL   032AH          00120 ;
7D05 3E3F     00180         LD     A,3FH          00130
7D07 CD2A03   00190         CALL   032AH          00140 W4UCH
7D0A 3E20     00200         LD     A,20H          00150
7D0C CD2A03   00210         CALL   032AH          00160 BEGIN
7D0F CD4900   00220         CALL   049H           00170
7D12 CD2A03   00230         CALL   032AH          00180
7D15 327B7D   00240         LD     (FUNCT),A      00190
7D18 3E0D     00250         LD     A,0DH          00200
7D1A CD2A03   00260         CALL   032AH          00210
7D1D 3E46     00270         LD     A,46H          00220
7D1F CD2A03   00280         CALL   032AH          00230
7D22 CDB31B   00290         CALL   1BB3H          00240
7D25 D7       00300         RST    10H            00250
7D26 CD6C0E   00310         CALL   0E6CH          00260
7D29 CD7F0A   00320         CALL   0A7FH          00270
7D2C E5       00330         PUSH   HL             00280
7D2D 3E53     00340         LD     A,53H          00290
7D2F CD2A03   00350         CALL   032AH          00300
7D32 CDB31B   00360         CALL   1BB3H          00310
7D35 D7       00370         RST    10H            00320
7D36 CD6C0E   00380         CALL   0E6CH          00330
7D39 CD7F0A   00390         CALL   0A7FH          00340
7D3C D1       00400         POP    DE             00350
7D3D 3A7B7D   00410         LD     A,(FUNCT)      00360
7D40 FE2B     00420         CP     2BH            00370
7D42 2823     00430         JR     Z,ADD          00380
7D44 FE2D     00440         CP     2DH            00390
7D46 2824     00450         JR     Z,SUB          00400
7D48 FE2A     00460         CP     2AH            00410
7D4A 2825     00470         JR     Z,MULT         00420
7D4C FE2F     00480         CP     2FH            00430
7D4E 2826     00490         JR     Z,DIVIDE       00440
7D50 3E3D     00500 VIDEO   LD     A,3DH          00450
7D52 CD2A03   00510         CALL   032AH          00460
7D55 3E20     00520         LD     A,20H          00470
7D57 CD2A03   00530         CALL   032AH          00480
7D5A CDBD0F   00540         CALL   0FBDH          00490
7D5D CDA728   00550         CALL   28A7H          00500
7D60 3E0D     00560         LD     A,0DH          00510
7D62 CD2A03   00570         CALL   032AH          00520
7D65 1899     00580         JR     BEGIN          00530 VIDEO
7D67 CDD20B   00590 ADD     CALL   0BD2H          00540
7D6A 18E4     00600         JR     VIDEO          00550
7D6C CDC70B   00610 SUB     CALL   0BC7H          00560
7D6F 18DF     00620         JR     VIDEO          00570
7D71 CDF20B   00630 MULT    CALL   0BF2H          00580
7D74 18DA     00640         JR     VIDEO          00590
7D76 CD9024   00650 DIVIDE  CALL   2490H          00600
7D79 18D5     00660         JR     VIDEO          00610
7D7B 00       00670 FUNCT   DEFB                  00620 ADD
7D00          00680         END    W4UCH          00630
00000 TOTAL ERRORS                                00640 SUB
                                                  00650
ADD    7D67 00590   00430                         00660 MULT
BEGIN  7D00 00160   00580                         00670
DIVIDE 7D76 00650   00490                         00680 DIVIDE
FUNCT  7D7B 00670   00240 00410                   00690
MULT   7D71 00630   00470                         00700 FUNCT
SUB    7D6C 00610   00450                         00710
VIDEO  7D50 00500   00600 00620 00640 00660
W4UCH  7D00 00140   00150 00680
```

Listing 3. Single precision source code.

```
SINGLE PRECISION DEMONSTRATION PROGRAM

USING LEVEL II ROM SUBROUTINES + - * /

EQU     7D00H           ;= 32000 DECIMAL
ORG     W4UCH           ;PROGRAM WILL START HERE
LD      A,4FH           ;"O" OPERATION DESIRED
CALL    032AH           ;DISPLAY "O" ON VIDEO
LD      A,3FH           ;= ASCII ?
CALL    032AH           ;DO IT - ON VIDEO
LD      A,20H           ;= ASCII SPACE
CALL    032AH           ;DO IT - ON VIDEO
CALL    049H            ;KYBD INPUT + - * /
CALL    032AH           ;DISPLAY FUNCTION
```

```
LD      (FUNCT),A       ;STASH DESIRED OPERATION
LD      A,0DH           ;0DH = SKIP A LINE
CALL    032AH           ;DO IT - ON VIDEO
LD      A,46H           ;"F" = FIRST NUMBER
CALL    032AH           ;DO IT - ON VIDEO
CALL    1BB3H           ;KYBD/VIDEO INPUT ROUTINE
RST     10H             ;SCAN $ SET "C" FLAG
CALL    0E6CH           ;ASCII-ACCUM RET MIN
CALL    0AB1H           ;CONV SINGLE PRECISION
CALL    09BFH           ;LOAD BCDE FROM ACCUM
PUSH    BC              ;STORE IN STACK
PUSH    DE              ;STORE IN STACK
LD      A,53H           ;"S" = 2ND NUMBER
CALL    032AH           ;DISPLAY "S" ON VIDEO
CALL    1BB3H           ;KYBD/VIDEO INPUT ROUTINE
RST     10H             ;SCAN $ SET "C" FLAG
CALL    0E6CH           ;ASCII$ TO ACCUM RET MIN
CALL    0AB1H           ;CONV TO SINGLE PRECISION
POP     DE              ;RESTORE DE REGISTER
POP     BC              ;RESTORE BC REGISTER
LD      A,(FUNCT)       ;RECALL + - * / FROM MEM
CP      2BH             ;IS IT + ?
JR      Z,ADD           ;IF SO GOTO ADD
CP      2DH             ;IS IT - ?
JR      Z,SUB           ;IF SO GOTO SUBTRACT
CP      2AH             ;IS IT * ?
JR      Z,MULT          ;IF SO GOTO MULTIPLY
CP      2FH             ;IS IT / ?
JR      Z,DIVIDE        ;IF SO GOTO DIVIDE
LD      A,3DH           ;3DH IS ASCII = SIGN
CALL    032AH           ;DO IT - ON VIDEO
LD      A,20H           ;= ASCII SPACE
CALL    032AH           ;DO IT - ON VIDEO
CALL    0FBDH           ;CONV ACCUM TO STRING
CALL    28A7H           ;DISPLAY STRING ON VIDEO
LD      A,0DH           ;= SKIP A LINE
CALL    032AH           ;DO IT - ON VIDEO
JR      BEGIN           ;REPEAT ROUTINE
CALL    0716H           ;ADD BCDE REGS TO ACCUM
JR      VIDEO           ;OUTPUT RESULT
CALL    0713H           ;SUB ACCUM FM BCDE REGS
JR      VIDEO           ;OUTPUT RESULT
CALL    0847H           ;MULT ACCUM * BCDE REGS
JR      VIDEO           ;OUTPUT RESULT
CALL    08A2H           ;DIV ACCUM INTO BCDE REGS
JR      VIDEO           ;OUTPUT RESULT
DEFB                    ;SAVE BYTE-STASH FUNCTION
END     W4UCH           ;EL FIN = EL PRIMERO
```

Listing 4. Single precision object code.

```
7D00            00140 W4UCH   EQU     7D00H
7D00            00150         ORG     W4UCH
7D00 3E4F       00160 BEGIN   LD      A,4FH
7D02 CD2A03     00170         CALL    032AH
7D05 3E3F       00180         LD      A,3FH
7D07 CD2A03     00190         CALL    032AH
7D0A 3E20       00200         LD      A,20H
7D0C CD2A03     00210         CALL    032AH
7D0F CD4900     00220         CALL    049H
7D12 CD2A03     00230         CALL    032AH
7D15 32807D     00240         LD      (FUNCT),A
7D18 3E0D       00250         LD      A,0DH
7D1A CD2A03     00260         CALL    032AH
7D1D 3E46       00270         LD      A,46H
7D1F CD2A03     00280         CALL    032AH
7D22 CDB31B     00290         CALL    1BB3H
7D25 D7         00300         RST     10H
7D26 CD6C0E     00310         CALL    0E6CH
7D29 CDB10A     00320         CALL    0AB1H
7D2C CDBF09     00330         CALL    09BFH
7D2F C5         00340         PUSH    BC
7D30 D5         00350         PUSH    DE
7D31 3E53       00360         LD      A,53H
7D33 CD2A03     00370         CALL    032AH
7D36 CDB31B     00380         CALL    1BB3H
7D39 D7         00390         RST     10H
7D3A CD6C0E     00400         CALL    0E6CH
7D3D CDB10A     00410         CALL    0AB1H
7D40 D1         00420         POP     DE
7D41 C1         00430         POP     BC
7D42 3A807D     00440         LD      A,(FUNCT)
7D45 FE2B       00450         CP      2BH
7D47 2823       00460         JR      Z,ADD
7D49 FE2D       00470         CP      2DH
7D4B 2824       00480         JR      Z,SUB
```

412EH, also eight bytes. NT will "blow" our whole subroutine if we try to perform arithmetic operations with dissimilar number types; i.e., add an integer to a double-precision number. ROM lets us use its CINT (CALL 0A7FH), CSGN (CALL 0AB1H), CDBL (CALL 0ADBH) functions with only a single CALL to make the numbers we are using compatible. The programs in this article provide these functions in each routine, so as long as you abide by each number type's minimal rules, you'll be OK.

The NT single-byte storage in RAM is located at 40AFH. NT (40AFH) requires 2 for an integer number, 3 for a string, 4 for a single-precision number and 8 for a double-precision number. To change these numbers to ASCII and display them on video, simply ADD 30H to the contents of MEM location 40AFH and output to the video display as follows:

```
LD    A,(40AFH)  ;NT location
ADD   A, 30H     ;convert to ASCII
CALL  232AH      ;display on video
```

Integer Arithmetic + − * /

Listing 1 is the source code and Listing 2 is the object code of the demonstration program that will allow you to add, subtract, multiply or divide integers strictly using the ROM subroutines. As soon as you press ENTER, you'll have the answer. This is faster than your Model I TRS-80 because: instead of using BASIC, you are now conversing with your Z-80 microprocessor directly—in its own language—with no interpreter required.

This integer program places the first number you input into the DE register, the second number you input into the HL register, and then CALL whatever + − * / operation you requested. This simple program is completely straightforward except for line 330's PUSH HL and line 400's POP DE.

The stack begins at RAM memory location 4288H when you operate in the SYSTEM mode. We are "saving" the first integer number in the stack by pushing HL in line 330. The program then uses the HL register to obtain the second number you input in line 340.

The POP DE in line 400 merely takes the previous HL value from the stack and places it into the DE register. The stack could care less where its contents go, since it is just a fancy FILO (first-in-last-out) memory created and controlled by your Z-80/ROM (unless you choose to modify its location with the LD SP (stack pointer) opcode and operand instruction).

Integer arithmetic is nothing more than placing the first number in the DE register, the second number in the HL register and specifying which + − * / operation you

```
7D4D FE2A      00490          CP     2AH
7D4F 2825      00500          JR     Z,MULT
7D51 FE2F      00510          CP     2FH
7D53 2826      00520          JR     Z,DIVIDE
7D55 3E3D      00530 VIDEO    LD     A,3DH
7D57 CD2A03    00540          CALL   032AH
7D5A 3E20      00550          LD     A,20H
7D5C CD2A03    00560          CALL   032AH
7D5F CDBD0F    00570          CALL   0FBDH
7D62 CDA728    00580          CALL   28A7H
7D65 3E0D      00590          LD     A,0DH
7D67 CD2A03    00600          CALL   032AH
7D6A 1894      00610          JR     BEGIN
7D6C CD1607    00620 ADD      CALL   0716H
7D6F 18E4      00630          JR     VIDEO
7D71 CD1307    00640 SUB      CALL   0713H
7D74 18DF      00650          JR     VIDEO
7D76 CD4708    00660 MULT     CALL   0847H
7D79 18DA      00670          JR     VIDEO
7D7B CDA208    00680 DIVIDE   CALL   08A2H
7D7E 18D5      00690          JR     VIDEO
7D80 00        00700 FUNCT    DEFB   0
7D00           00710          END    W4UCH
00000 TOTAL ERRORS

ADD     7D6C 00620    00460
BEGIN   7D00 00160    00610
DIVIDE  7D7B 00680    00520
FUNCT   7D80 00700    00240 00440
MULT    7D76 00660    00500
SUB     7D71 00640    00480
VIDEO   7D55 00530    00630 00650 00670 00690
W4UCH   7D00 00140    00150 00710
```

Listing 5. Double precision source code.

```
00140 W4UCH    EQU    7D00H          ;= 32000 DECIMAL
00150          ORG    W4UCH          ;PROGRAM WILL START HERE
00160 BEGIN    LD     A,4FH          ;"O" OPERATION DESIRED
00170          CALL   032AH          ;DISPLAY "O" ON VIDEO
00180          LD     A,3FH          ;= ASCII ?
00190          CALL   032AH          ;DO IT - ON VIDEO
00200          LD     A,20H          ;= ASCII SPACE
00210          CALL   032AH          ;DO IT - ON VIDEO
00220          CALL   049H           ;KYBD INPUT + - * /
00230          CALL   032AH          ;DISPLAY FUNCTION
00240          LD     (FUNCT),A      ;STASH DESIRED OPERATION
00250          LD     A,0DH          ;0DH = SKIP A LINE
00260          CALL   032AH          ;DO IT - ON VIDEO
00270          LD     A,46H          ;"F" = FIRST NUMBER
00280          CALL   032AH          ;DO IT - ON VIDEO
00290          CALL   1BB3H          ;KYBD/VIDEO INPUT ROUTINE
00300          RST    10H            ;SCAN $ SET "C" FLAG
00310          CALL   0E65H          ;ASCII$ TO ACCUM RET CDBL
00320          LD     DE,411DH       ;MOVE FROM ACCUM RAM MEM
00330          LD     HL,TACCUM      ;TO TEMPORARY ACCUM STASH
00340          LD     B,8            ;NUMBER OF BYTES TO MOVE
00350          CALL   09D7H          ;MOVE IT - SUBROUTINE
00360          LD     A,53H          ;"S" = 2ND NUMBER
00370          CALL   032AH          ;DISPLAY "S" ON VIDEO
00380          CALL   1BB3H          ;KYBD/VIDEO INPUT ROUTINE
00390          RST    10H            ;SCAN $ SET "C" FLAG
00400          CALL   0E65H          ;ASCII$ TO ACCUM RET CDBL
00410          CALL   09FCH          ;TRANSFER ACCUM TO CDBL
00420          LD     DE,TACCUM      ;MOVE ACCUM FROM STASH TO
00430          LD     HL,411DH       ;PERMANENT RAM LOCATION
00440          LD     B,8            ;NUMBER OF BYTES TO MOVE
00450          CALL   09D7H          ;MOVE IT - RIGHT NOW
00460          LD     A,(FUNCT)      ;RECALL + - * / FROM MEM
00470          CP     2BH            ;IS IT + ?
00480          JR     Z,ADD          ;IF SO GOTO ADD
00490          CP     2DH            ;IS IT - ?
00500          JR     Z,SUB          ;IF SO GOTO SUBTRACT
00510          CP     2AH            ;IS IT * ?
00520          JR     Z,MULT         ;IF SO GOTO MULTIPLY
00530          CP     2FH            ;IS IT / ?
00540          JR     Z,DIVIDE       ;IF SO GOTO DIVIDE
00550 VIDEO    LD     A,3DH          ;3DH IS ASCII = SIGN
00560          CALL   032AH          ;DO IT - ON VIDEO
00570          LD     A,20H          ;= ASCII SPACE
00580          CALL   032AH          ;DO IT - ON VIDEO
00590          CALL   0FBDH          ;CONV ACCUM TO STRING
00600          CALL   28A7H          ;DISPLAY STRING ON VIDEO
00610          LD     A,0DH          ;= SKIP A LINE
00620          CALL   032AH          ;DO IT - ON VIDEO
00630          JR     BEGIN          ;REPEAT ROUTINE
00640 ADD      CALL   0C77H          ;ADD ACCUM TO CDBL
```

desire with the following CALLs:

ADD = CALL 0BD2H
MULTIPLY = CALL 0BF2H
SUBTRACT = CALL 0BC7H
DIVIDE = CALL 2490H

The result of any of these operations is always placed in the ACCUM. To display the result on video:

CALL 0FBDH ;convert ACCUM to ASCII string
CALL 28A7H ;display ASCII string on video

Single-Precision Arithmetic + − * /

Single-precision arithmetic is similar to integer arithmetic, except ROM now wants the first number in registers BC and DE, and the second number in the ACCUM. The desired operation is performed by:

ADD = CALL 0716H
MULTIPLY = CALL 0847H
SUBTRACT = CALL 0713H
DIVIDE = CALL 08A2H

For memory storage, we again use the stack as shown in lines 340 and 350 PUSH instructions and lines 420 and 430 POP. Listings 3 and 4 are the source code and object code, respectively, for the single-precision arithmetic demonstration program.

Double-Precision Arithmetic + − * /

Double-precision arithmetic is not significantly different from either integer or single-precision arithmetic subroutines, except now ROM wants the first number in the ACCUM and the second number in the CDBL store RAM location. To do this:

ADD = CALL 077CH
MULTIPLY = CALL 0DA1H
SUBTRACT = CALL 0C70H
DIVIDE = CALL 0DE5H

The source and object codes for the double-precision arithmetic demonstration program are shown in Listings 5 and 6.

Summary

Each of these source code programs may be input by the user in about five minutes with the Radio Shack editor/assembler. There is absolutely no reason now why you can't talk to your Z-80 microcomputer and Level II ROM in its own language, rather than through a BASIC interpreter. The resulting program's capability of running over 300 times faster than BASIC in only 1/10th the memory is well worth the few weeks required to master this new approach. ■

TRS-80 Disassembled Handbook, Vol. 1 is available for $10 ppd, and *Vol. 2* is $15 ppd. from:
Richcraft Engineering Ltd.
Drawer 1065
Chautauqua Lake, NY 14722
Phone (716) 753-2654 for COD orders.

```
00650          JR      VIDEO          ;OUTPUT RESULT
00660 SUB      CALL    0C70H          ;SUBTRACT CDBL FROM ACCUM
00670          JR      VIDEO          ;OUTPUT RESULT
00680 MULT     CALL    0DA1H          ;MULTIPLY ACCUM * CDBL
00690          JR      VIDEO          ;OUTPUT RESULT
00700 DIVIDE   CALL    0DE5H          ;DIVIDE ACCUM BY CDBL
00710          JR      VIDEO          ;OUTPUT RESULT
00720 FUNCT    DEFB                   ;SAVE BYTE-STASH FUNCTION
00730 TACCUM   DEFS    8              ;TEMPORARY ACCUM STASH
00740          END     W4UCH          ;AMATEUR RADIO CALL LTRS
```

Listing 6. Double precision object code.

```
7D00             00140 W4UCH    EQU     7D00H
7D00             00150          ORG     W4UCH
7D00  3E4F       00160 BEGIN    LD      A,4FH
7D02  CD2A03     00170          CALL    032AH
7D05  3E3F       00180          LD      A,3FH
7D07  CD2A03     00190          CALL    032AH
7D0A  3E20       00200          LD      A,20H
7D0C  CD2A03     00210          CALL    032AH
7D0F  CD4900     00220          CALL    049H
7D12  CD2A03     00230          CALL    032AH
7D15  328C7D     00240          LD      (FUNCT),A
7D18  3E0D       00250          LD      A,0DH
7D1A  CD2A03     00260          CALL    032AH
7D1D  3E46       00270          LD      A,46H
7D1F  CD2A03     00280          CALL    032AH
7D22  CDB31B     00290          CALL    1BB3H
7D25  D7         00300          RST     10H
7D26  CD650E     00310          CALL    0E65H
7D29  111D41     00320          LD      DE,411DH
7D2C  218D7D     00330          LD      HL,TACCUM
7D2F  0608       00340          LD      B,8
7D31  CDD709     00350          CALL    09D7H
7D34  3E53       00360          LD      A,53H
7D36  CD2A03     00370          CALL    032AH
7D39  CDB31B     00380          CALL    1BB3H
7D3C  D7         00390          RST     10H
7D3D  CD650E     00400          CALL    0E65H
7D40  CDFC09     00410          CALL    09FCH
7D43  118D7D     00420          LD      DE,TACCUM
7D46  211D41     00430          LD      HL,411DH
7D49  0608       00440          LD      B,8
7D4B  CDD709     00450          CALL    09D7H
7D4E  3A8C7D     00460          LD      A,(FUNCT)
7D51  FE2B       00470          CP      2BH
7D53  2823       00480          JR      Z,ADD
7D55  FE2D       00490          CP      2DH
7D57  2824       00500          JR      Z,SUB
7D59  FE2A       00510          CP      2AH
7D5B  2825       00520          JR      Z,MULT
7D5D  FE2F       00530          CP      2FH
7D5F  2826       00540          JR      Z,DIVIDE
7D61  3E3D       00550 VIDEO    LD      A,3DH
7D63  CD2A03     00560          CALL    032AH
7D66  3E20       00570          LD      A,20H
7D68  CD2A03     00580          CALL    032AH
7D6B  CDBD0F     00590          CALL    0FBDH
7D6E  CDA728     00600          CALL    28A7H
7D71  3E0D       00610          LD      A,0DH
7D73  CD2A03     00620          CALL    032AH
7D76  1888       00630          JR      BEGIN
7D78  CD770C     00640 ADD      CALL    0C77H
7D7B  18E4       00650          JR      VIDEO
7D7D  CD700C     00660 SUB      CALL    0C70H
7D80  18DF       00670          JR      VIDEO
7D82  CDA10D     00680 MULT     CALL    0DA1H
7D85  18DA       00690          JR      VIDEO
7D87  CDE50D     00700 DIVIDE   CALL    0DE5H
7D8A  18D5       00710          JR      VIDEO
7D8C  00         00720 FUNCT    DEFB    0
0008             00730 TACCUM   DEFS    8
7D00             00740          END     W4UCH
 00000 TOTAL ERRORS

 ADD     7D78 00640   00480
 BEGIN   7D00 00160   00630
 DIVIDE  7D87 00700   00540
 FUNCT   7D8C 00720   00240 00460
 MULT    7D82 00680   00520
 SUB     7D7D 00660   00500
 TACCUM  7D8D 00730   00330 00420
 VIDEO   7D61 00550   00650 00670 00690 00710
```

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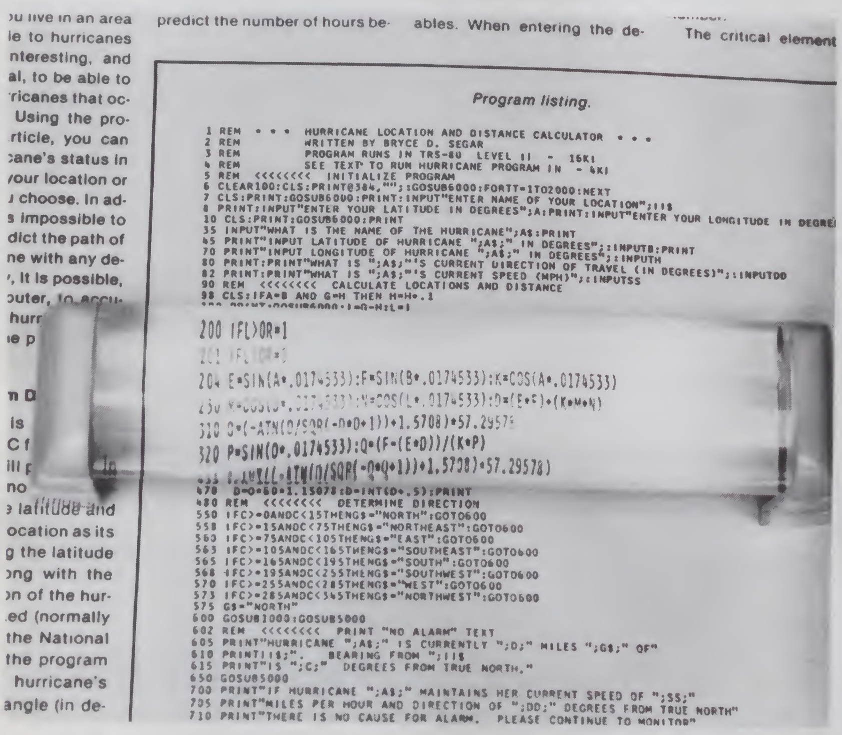
Agoura, CA 91301

Minilisting Magnifier

Focus in on program listings.

(Left) Magnifier in use on machine-language listing. Note edge of metal sheet protruding from under magazine page.



(Below) Miniprogram magnifier adhering to magazine. Distortion is minimal when viewed at 90 degrees to copy.

Have you ever gone half-blind trying to key in one of those microscopic *Microcomputing* listings? You can save your eyes, avoid headaches and lessen typing errors with this simple and inexpensive magnifying unit.

First, you'll need Directory Magnifier No. 5494, manufactured in England by Combined Optical Industries Limited. This five-power magnifier assembly is 5¼ × 1 inches and costs $4.25. Your stationery store should carry it; if not, I've listed a supplier at the end of this article.

Next, pick up a pair of Rogers Handy Magnets, manufactured by Rogers Products, Route 7, Box 347, Ft. Worth, TX 76119. They measure 3/4 × 3/16 × 3/16 inches and come six to a pack for $1.

To put the assembly together, first turn the magnifier over. Note that each side support is hollow-molded. One magnet will fit perfectly in the space on each side. Use fast-setting epoxy glue to secure them, with the flat sides out.

Holding the assembly while the epoxy is setting may be a delicate operation, since the magnet must be located carefully. A "third hand" tool helps, but remember that metal tongs will be attracted to the magnet. After the magnets are secure, the magnifier is ready to use.

There are two ways to make a copy holder. If you tear the pages out of your magazine, a metal but not aluminum copy stand will do. They cost $3–$8; the cheapest one is adequate. Simply put the program on the copy stand and place the magnifier on the listing. The magnifier will hold as many as eight magazine pages.

You'll get about five lines without distortion, and with an amazing increase in size. Typewriter-sized listings will be huge.

If you don't like to tear program listings out of your magazines, you have an alternative.

Instead of a copy stand, buy a clipboard, the kind with a large metal clamp at the top. Pick up an 8 × 10 inch sheet of galvanized metal at a plumbing or building supplies store. They usually come in a standard thickness. Be sure that you round the corners.

Place the sheet metal behind the page the listing is on and attach the book to the clipboard. Put the magnifier on the listing and proceed.

This arrangement works well for single sheets, magazines and even books.

The magnifier is also useful for scanning extremely small type in the advertisements in the back of computer magazines.

All of the parts mentioned, except the metal sheeting, may be purchased from County Stationers, Inc., 532 E. Main St., Ventura, CA 93001. ■

PROM Adapter for the SWTP 6800

Free up your memory sockets.

David V. Hallidy
3400 Ridgeglen Circle
Plano, TX 75074

As a new owner of the Southwest Technical Products 6800/2 computer system, I was disappointed that the operating system supplied with the kit (SWTBUG) was in ROM rather than EPROM.

I had wanted to develop and evaluate my own custom monitor and had to use the four EPROM sockets installed on the CPU board. But a problem arises when adding both a custom monitor and some other custom software (in my case, an editor-

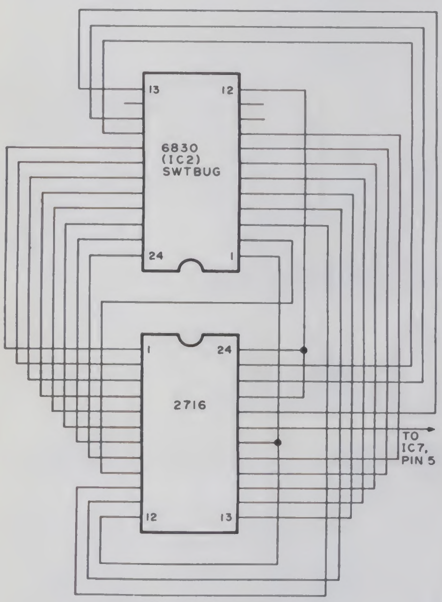


Fig. 1. Circuit diagram.

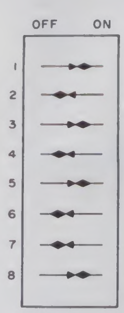


Fig. 2. DIP switch configuration.

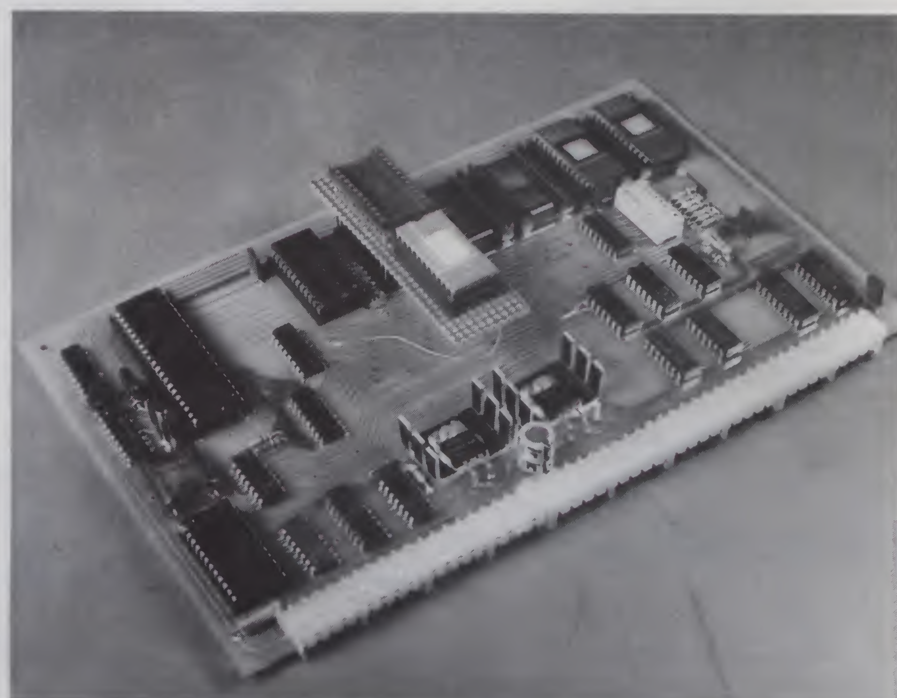


Photo 1. Adapter modification.

assembler).

The architecture of the SWTP 6800 requires that the monitor begin at hex location E000. If the 8K of PROM sockets are configured to accept this, then nothing else can be added that requires more than the space available from the end of the monitor program to location FFFE (the beginning of the restart vector address). This severely restricts potential program size. I needed to find a way to use a monitor in EPROM, yet still have the PROM sockets uncommitted so I could use them for other purposes.

To solve this problem, I constructed an adapter to connect an Intel 2716 to the socket normally reserved for a Motorola 6830 ROM (not pin-compatible devices). Although this particular modification was performed on an SWTP 6800 with the latest (MP-A2) version CPU board, the basic idea should be applicable to any machine.

Photo 1 shows the adapter. I built it on a 1 × 3 inch piece of vector board, which holds two 24-pin wire-wrap IC sockets. The lower socket holds the 2716, while the upper one plugs into the 6830 socket (IC2) on the CPU board. Use Table 1 as a wire list to wire the corresponding pins from the 6830 socket to the 2716 socket.

Fig. 1 is a schematic of the circuit, while Fig. 2 shows the configuration of the DIP switch on the CPU. After wiring is complete, cut the legs of the 2716 socket as short as possible so they don't inadvertently contact the CPU board.

Note also that SWTP orients pin 1 on the 6830 toward the lower edge of the CPU board (a mistake here could be fatal). Since the 2716 is a 2K device, an added address line (A10) not available on the 6830 socket is required. I ran a wire from the 2716 socket pin 19 to IC7, pin 5, on the CPU board. A pad on the CPU near IC7 is convenient for soldering this wire.

The only other modification to the CPU board involves the chip select signal (pin 13 on the 6830). The 6830 requires an active high chip enable, while the chip enable signal on the 2716 is active low. SWTP conveniently inverts the normally low-going chip enable line with IC14, pins 1 and 2. Break only the foil going to pin 2 and run a jumper from the foil run to pin 1 of IC14. The other chip select signals on the 6830 are not used on the 2716.

Note also in Table 1 that you must tie pin 21 of the 2716 to pin 24 and pin 18 to pin 12.

This modification allows up to 2K of monitor to be installed, leaving all of the user 8K available for other purposes. If you need to switch back to SWTBUG, simply unplug the 2716 from its socket and install the 6830 into its socket on the adapter board. Remember to move the jumper on IC14 back to pin 2 and reconfigure the DIP switch per the instructions in the SWTP manual. ■

From 6830 Pin		To 2716 Pin
2	D0	9
3	D1	10
4	D2	11
5	D3	13
6	D4	14
7	D5	15
8	D6	16
9	D7	17
24	A0	8
23	A1	7
22	A2	6
21	A3	5
20	A4	4
19	A5	3
18	A6	2
17	A7	1
16	A8	23
15	A9	22
13	/SEL	20
12	VCC	24
1	GND	12

From 2716 Pin		To 2716 Pin
12	PROG	18
24	VPP	21
19	To pad near IC7-5 on CPU board	

Table 1. Wire list.

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FILEMAP:
An Aid to Program Documentation

Keep track of your variables with this helpful program.

Douglas L. Jones
2271 North Mill
North East, PA 16428

Writing and debugging a program in any language is perhaps the easiest part of programming, but documenting the program is perhaps the most important. Documentation might include a user's manual or instructions, flowcharts, detailed descriptions of algorithms or a list of variables describing their use in the program. Support documentation allows you, or someone else at a much later date, to adjust or modify the program. Without the documentation, this can be a difficult task.

The variable mapping program described here will help you with a part of the documentation—the variable list. It will give your program two cross-references: a list by line number of what variables appear on each line and an alphabetical list of the variables showing (in numeric order) on what line numbers they appear. The program is capable of aiding you in describing the purpose of each variable by presenting a variable and allowing you to type in the purpose or meaning.

To run this program on your system, you will probably need to make minor modifications. The program was originally written on an Altair 680b with 8K BASIC, 16K of memory and an audio cassette for storage. It was subsequently and easily modified to run on an Altair 8080b with 64K of memory in Extended Disk BASIC. The disk version is shown. There were 77 data elements in the 680 version and 129 elements in the 8080 version. These data elements are not a function of the MPU chip, but rather a function of the complexity of the BASIC interpreter.

Program Operation

Save a copy of your program as an ASCII file (e.g., SAVE "QUIRK," 0, A). Load and run FILEMAP, which will ask you the name of your ASCII file, the name for an output or spooling file to write the results to and whether you want to document the variables by adding their purpose.

With its string searches and comparisons, the program is slow-footed. It will tell you how many lines your ASCII file contains and will slowly count up to that total. When it is finished, if you have chosen to document, it will present each variable and allow you to attach your comments. This phase also allows you to review and modify any of your comments. The added information is also written to your output file.

The Spool program allows you to print your output file and obtain the hard-copy listing. Use the program so you won't have to keep your printer running during the long time the program is running.

```
10 CLEAR300:WIDTH80
20 PRINTCHR$(12):INPUT"OUTPUT FILE NAME";F1$
30 OPEN"I",1,F1$
40 IF EOF(1) THEN 80
50 LINE INPUT #1,A$
60 PRINT A$
70 GOTO40
80 CLOSE
90 END
```

Spool listing.

Sample run.

```
10 W=X+Y
20 PRINT "HELLO";A;B;C;C
30 REM ABCDEFG

SAVE "TEST", 0, A

RUN"FILEMAP"

INPUT ASCII FILE NAME? TEST

OUTPUT FILE NAME? ZAP
```

```
*******************************

STATISTICS ON           FILEMAP

LINE COUNT              129
UNIQUE LINES            100

VARIABLE COUNT          409
UNIQUE VARIABLES        43

*******************************
```

FILEMAP statistics.

The program contains as data statements a list of every command the BASIC interpreter will support. They remain in pseudo-alphabetical order as the result of a false start on a search method. You could speed up the program by placing commands in descending order of their use. In some cases I deliberately went out of alphabetical order (AS is after ASC, ERR is after ERROR). If alphabetical order were followed, the program would find a variable C in ASC, for example.

A delimiter string contains a carriage return, line feed, vertical and horizontal tabs, a space and the punctuation marks #&* + −/<=>\'():;,.. Quotation marks are most important to spot so the program will quickly get through PRINT statements. They require special handling in line 910, along with DATA statements (line 940), REM statements (line 980) and parentheses indicating subscripted variables (line 990).

As each line of the target program is brought in from disk, it is first stripped of the line number, which is stored in array B(). The remaining string is analyzed by the following logic:

Is the first character a quote?
Is the first word DATA?
Is the first character # indicating a hexadecimal variable?
If the first word is REM, then skip the entire line.
Is the first character a (?
Is the first character a number?
Is the first character any of the known delimiters?
Is there a match on the first (x) characters with any of the commands?

If none of the above hold true, nip off the first letter, which is the start of a variable, shorten the line by one character and go back to the top of the list of checks.

As each variable is found, it is stored in a matching array B$(). Line 900 contains diagnostic PRINT statements. To activate this line, edit out the REM statement at the beginning of this line.

When all the lines in the target have been processed, the first listing is spooled to your output file; the variables are listed by line number. Line numbers without variables are not printed.

Variables are swapped in preparation for the two sorts that are utilized to get the data for the alphabetic listing by line number. The first sort is a modified Shell sort used for speed during the alphabetic sort. The second is a modified ripple sort—slower but used to sort the line numbers within the variable. The ripple sort will allow a lower limit and upper limit (LL and UL) to be set, limiting the extent of the sort.

The second listing is spooled to the output file, and the documentation phase begins.

```
DO YOU WISH TO DOCUMENT YOUR VARIABLES (Y)ES? Y

TEST :  LINE COUNT IS 3

 1  2  3

UNIQUE VARIABLES  6  IN  TEST
READY TO BEGIN DOCUMENTATION

VARIABLE   A ? # APPLES

VARIABLE   B ? # BOYS ON A TEAM

VARIABLE   C ? # CHEERLEADERS WITH BIG POM-POMS

VARIABLE   W ? WHITE CADILLACS

VARIABLE   X ? THE UNKNOWN

VARIABLE   Y ? YOUR GUESS

REVIEW

 1 A          # APPLES
 2 B          # BOYS ON A TEAM
 3 C          # CHEERLEADERS WITH BIG POM-POMS
 4 W          WHITE CADILLACS
 5 X          THE UNKNOWN
 6 Y          YOUR GUESS

ANY CHANGES (Y)ES (N)O (R)EVIEW? N

          FILE  ZAP  COMPLETE


RUN "SPOOL"
OUTPUT FILE NAME? ZAP



VARIABLES BY LINE NUMBER

 10       W X Y
 20       A B C C


VARIABLES ALPHABETICALLY

A          20
B          20
C          20  20
W          10
X          10
Y          10


******************************

STATISTICS ON          TEST

LINE COUNT             3
UNIQUE LINES           2

VARIABLE COUNT         7
UNIQUE VARIABLES       6

******************************


      A        # APPLES
      B        # BOYS ON A TEAM
      C        # CHEERLEADERS WITH BIG POM-POMS
      W        WHITE CADILLACS
      X        THE UNKNOWN
      Y        YOUR GUESS
```

FILEMAP variables.

```
A$        TEMPORARY INPUT STRING
B         USED IN ERASE STATEMENT TO CLEAR ARRAY B()
BS        NUMBER OF DATA ELEMENTS
B$        USED IN ERASE STATEMENT TO CLEAR ARRAY B$()

B$()      ARRAY USED TO STORE VARIABLES AS THEY ARE FOUND
          EXAMPLE: B$(107) = B$() LC B$() LC S1$ VC VC PR

B()       STORAGE FOR LINE NUMBERS
          EXAMPLE: B(107)=1070

C$()      TRANSFERRED VARIABLES FROM B$()
          C$(X) CONTAINS ONLY ONE VARIABLE
```

```
C()      TRANSFERRED LINE NUMBERS FROM B()
CX$      CLEAR TERMINAL SCREEN CHARACTER
D        LENGTH OF DELIMETER STRING D$
D$       DELIMETER STRING
DF       DATA STATEMENT FLAG
DV$      DOCUMENT VARIABLES ?? ANSWER
F1$      INPUT FILE NAME
F2$      OUTPUT FILE NAME
FL       SEARCH FLAG  0 = NO MATCH
I        LOOP COUNTER
J        LOOP COUNTER ON MAJOR LOOP AND ALSO USED IN SHELL SORT
K        USED AS POINTER IN SHELL SORT
L        LOOP COUNTER IN RIPPLE SORT
LC       INPUT LINE COUNTER  (REDUNDANT VALUE WITH T1)
LL       LOWER LIMIT HANDED TO RIPPLE SORT
LN       TEMPORARY CALCULATION OF STRIPPED LINE NUMBER
LU       NUMBER OF UNIQUE LINES
M        CALCULATION OF POINTER IN SHELL SORT
N        LOOP COUNTER
P        GENERAL POINTER

PB       POINTER TO DEPTH OF VARIABLE IN STRING B$()
PC       POINTER TO WHICH C() AND C$() TO STORE DATA IN
PL       POINTER TO WHICH B() AND B$() ARE BEING ADDRESSED

         PB PC PL ARE USED DURING TRANSFER OF B$() AND B()
         TO C$() AND C()

PR       PARENTHESIS FLAG
QF       QUOTATION FLAG
```

I made every effort to save memory with this program. It would have looked nicer if I had used a top-down and structured approach.

Modifying the Program

You should not have too much trouble modifying it to run on your system. Start by making a detailed list of every command that your BASIC will support. These will become the data statements. Adjust variable BS to reflect the number of DATA elements. Adjust delimiter string D$ to add or eliminate unwanted delimiters. Carefully look at the order of DATA elements for "contained-ins" (as in the AS / ASC example). Rearrange their order in the DATA element list.

Add any IF statements after line 900 to support any special conditions that your

S	LENGTH OF S$
S$	MAJOR STRING (INPUT LINE) THAT IS OPERATED ON
S1$	STORES START OF A VARIABLE AS IT IS FOUND
S2$	TEST CHARACTER, FIRST CHARACTER OF S$
T	LENGTH OF TEST WORD
T$	TEST WORD (DATA ELEMENT) / ALSO JUNK VARIABLE
T1	INPUT STRING COUNTER
UL	UPPER LIMIT OF SORT PASSED TO RIPPLE SORT
UV	NUMBER OF UNIQUE VARIABLES
VC	NUMBER OF TOTAL VARIABLES
Z	JUNK LOOP COUNTER

Program listing. FILEMAP program written in Altair Extended Disk BASIC.

```
50 DATAABS,AND,ASC,AS
60 DATAATN,AUTO,CDBL,CHR$,CINT,CLEAR,CLOAD,CLOSE,CONSOLE,CONT
70 DATACOS,CSAVE,CSNG,CVD,CVI,CVS,DEFDBL,DEFINT
80 DATADEFSNG,DEFSTR,DEFUSR,DEF,DELETE,DIM,DSKF,DSKI$,DSKINI,DSKO$,EDIT
90 DATAELSE,END,EOF,EQV,ERASE,ERL,ERROR,ERR,EXP,FIELD
100 DATAFILES,FIX,FN,FOR,FRCINT,FRE,GET,GOSUB,GOTO,HEX$
110 DATAIF,IMP,INPUT,INP,INSTR,INT,KILL,LEFT$,LEN,LET
120 DATALINE,LIST,LLIST,LOAD,LOC,LOF,LOG,LPOS,LPRINT,LSET
130 DATAMERGE,MID$,MKD$,MKI$,MKS$,MOD,MOUNT,NAME,NEW
140 DATANEXT,NOT,NULL,OCT$,ON,OPEN,OR,OUT,PEEK,POKE
150 DATAPOS,PRINT,PUT,READ,RENUM,RESTORE,RESUME,RETURN,RIGHT$
160 DATARND,RSET,RUN,SAVE,SGN,SIN,SPACE$,SPC,SQR
170 DATASTEP,STOP,STR$,STRING$,SWAP,TAB,TAN,THEN,TO
180 DATATROFF,TRON,UNLOAD,USING,USR,VAL,VARPTR,WAIT,WIDTH,XOR
190 CLEAR5000:BS=129:CX$=CHR$(12)
200 PRINTCX$:PRINTTAB(10);"FILEMAP : VARIABLE MAPPING PROGRAM":PRINT:PRINT
210 INPUT"INPUT ASCII FILE NAME";F1$
220 PRINT:PRINT:INPUT"OUTPUT FILE NAME";F2$
230 PRINT:PRINT:INPUT"DO YOU WISH TO DOCUMENT YOUR VARIABLES (Y)ES";DV$
240 D$=CHR$(9)+CHR$(10)+CHR$(12)+CHR$(13)+" #&*+-/<=>\^():;,.":D=LEN(D$)
250 OPEN"I",1,F1$:OPEN"O",2,F2$
260 IFEOF(1)THEN280
270 LINEINPUT#1,A$:T1=T1+1:GOTO260
280 CLOSE1:T1=T1-1:DIMB$(T1),B(T1)
290 PRINTCX$:PRINTF1$;" :  LINE COUNT IS";T1:PRINT
300 OPEN"I",1,F1$:LINEINPUT#1,A$
310 FORJ=1TOT1:LINEINPUT#1,S$:S$=S$+" ":GOSUB850:NEXTJ:CLOSE1
```

BASIC will allow; delete any IF statements or portions that do not apply. Carefully make these changes after analyzing a few trial runs against your programs and finding that FILEMAP has found an odd-looking variable or two.

Some BASICs may not support the SWAP statement at line 1220. If yours doesn't, just swap to a dummy variable (e.g., T = C(I): C(I) = C(L): C(L) = T).

If you do not wish to "spool," but would rather go directly to your printer, eliminate or modify the references to FILE #2. PRINT #2 becomes PRINT, and OPEN and CLOSE statements referencing #2 are eliminated.

The sample run, although edited for clarity, shows all of the features of FILEMAP. A simple three-line program is saved as an ASCII file. FILEMAP is run and a YES answer is given to DO YOU WANT TO DOCUMENT THE VARIABLES? The documentation is added to the variables and this, too, is stored in the output file. The Spool program is run to list the output file ZAP.

FILEMAP is capable of documenting itself. I used it as the primary test file during the writing and debugging. The entire output from running FILEMAP against itself is lengthy. The statistics and variable descriptions are, however, included. ■

```
320 PRINT#2,:PRINT#2,:PRINT#2,:PRINT#2,
330 PRINT#2,"VARIABLES BY LINE NUMBER":PRINT#2,
340 LU=LC:FORN=1TOLC:IFB$(N)=""THENLU=LU-1:GOTO410
350 PRINT#2,B(N);TAB(10);
360 P=0:FORZ=1TOLEN(B$(N)):T$=MID$(B$(N),Z,1)
370 P=P+1:IFP>=50ANDT$=" "THENPRINT#2,:PRINT#2,TAB(10);:P=0:GOTO390
380 PRINT#2,T$;
390 NEXTZ
400 PRINT#2,
410 NEXTN:PRINT#2,:PRINT#2,:GOSUB1230
420 M=VC:N=VC:GOSUB1160:FORN=1TOVC-1:LL=N:UL=N:IFC$(N)<C$(N+1)THEN460
430 IFC$(N)<>C$(UL)THENUL=UL-1:GOSUB1140:N=UL:GOTO460
440 IFUL<VCTHENUL=UL+1:GOTO430
450 GOSUB1140
460 NEXTN
470 PRINT#2,"VARIABLES ALPHABETICALLY":PRINT#2,
480 UV=VC:FORN=1TOVC:P=0:PRINT#2,C$(N);TAB(10);
490 P=P+LEN(STR$(C(N))):PRINT#2,C(N);
500 IFP>=50THENP=0:PRINT#2,:PRINT#2,TAB(10);
510 IFN=VCTHEN530
520 IFC$((N+1))=C$(N)THENN=N+1:UV=UV-1:GOTO490
530 PRINT#2,:NEXTN:PRINT#2,:PRINT#2,
540 FORN=1TO30:PRINT#2,"*";:NEXT:PRINT#2,:PRINT#2,
550 PRINT#2,"STATISTICS ON ";TAB(21);F1$:PRINT#2,
560 PRINT#2,"LINE COUNT";TAB(20);LC
570 PRINT#2,"UNIQUE LINES";TAB(20);LU
580 PRINT#2,:PRINT#2,"VARIABLE COUNT";TAB(20);VC
590 PRINT#2,"UNIQUE VARIABLES";TAB(20);UV
600 PRINT#2,:FORN=1TO30:PRINT#2,"*";:NEXT:PRINT#2,
610 PRINT#2,:PRINT#2,:PRINT#2,
620 DV$=LEFT$(DV$,1):IFDV$<>"Y"THEN820
630 ERASEB$,B:DIMB$(UV,1):P=0:FORN=1TO(VC-1):IFC$(N)=C$(N+1)THEN650
640 P=P+1:B$(P,0)=STR$(C(N)):B$(P,1)=C$(N)
650 NEXTN:P=P+1:IFP>UVTHEN670
660 B$(P,0)=C$(VC):B$(P,1)=C$(VC)
670 PRINTCX$:PRINT"UNIQUE VARIABLES ";UV;" IN  ";F1$
680 PRINT"READY TO BEGIN DOCUMENTATION":PRINT:PRINT
690 FORN=1TOUV:PRINT"VARIABLE   ";B$(N,1),
700 PRINT"? ";:LINEINPUTB$(N,0):NEXTN
710 GOSUB830:PRINT:PRINT
720 INPUT "ANY CHANGES (Y)ES (N)O (R)EVIEW";A$
730 IFA$<>"Y"ANDA$<>"N"ANDA$<>"R"THEN720
740 IFA$="R"THENGOSUB830:GOTO720
750 IFA$="N"THEN790
760 INPUT"ENTRY NUMBER ";P:PRINTP;B$(P,1),B$(P,0)
770 T$="":PRINT:PRINT"? ";:LINEINPUTT$:IFT$=""THEN720
780 B$(P,0)="":B$(P,0)=T$:GOTO720
790 FORN=1TO10:PRINT#2,:NEXT
800 FORN=1TOUV:PRINT#2,TAB(5);B$(N,1),B$(N,0):NEXTN
810 FORN=1TO10:PRINT#2,:NEXT
820 CLOSE:PRINTCX$:PRINTTAB(10);"FILE  ";F2$;"  COMPLETE":PRINT:END
830 PRINTCX$:PRINT"REVIEW":PRINT
840 FORN=1TOUV:PRINTN;B$(N,1),B$(N,0):NEXTN:PRINT:RETURN
850 P=1:QF=0:DF=0:PR=0
860 LN=VAL(LEFT$(S$,P)):IFASC(MID$(S$,P,1))<>32THENP=P+1:GOTO860
870 S$=RIGHT$(S$,LEN(S$)-P):S=LEN(S$):LC=LC+1:B(LC)=LN:PRINTLC;
880 S1$="":S2$="":IFS=0THENRETURN
890 S2$=LEFT$(S$,1)
900 REM   PRINTS$:PRINTTAB(10);S1$,S2$,B$(J): REM  *****************
910 IFQF=0ANDS2$=CHR$(34)THENQF=1:GOSUB1080:GOTO890
920 IFQF=1ANDS2$<>CHR$(34)THENGOSUB1080:GOTO890
930 IFQF=1ANDS2$=CHR$(34)THENQF=0:GOSUB1080:GOTO880
940 IFDF=0ANDLEFT$(S$,4)="DATA"THENDF=1:S$=RIGHT$(S$,S-4):GOTO890
950 IFDF=1ANDS2$<>":"ANDLEN(S$)<>1THENGOSUB1080:GOTO890
960 IFDF=1THENDF=0:GOSUB1080:GOTO880
970 IFS2$="#"ANDS1$<>""THENGOTO1060
980 IFLEFT$(S$,3)="REM"ORLEFT$(S$,1)="'"THENRETURN
990 IFPR=1ANDS2$="("THENS1$=S1$+"()":GOSUB1070:GOSUB1080:GOTO880
1000 IFS1$=""ANDVAL(S2$)<>0ORS2$="0"THENGOSUB1080:GOTO880
1010 FL=0:FORN=1TOD:IFMID$(D$,N,1)=S2$THENFL=1:N=D
1020 NEXTN:IFFL=1ANDS1$<>""THENGOSUB1070:GOSUB1080:GOTO880
1030 IFFL=1ANDS1$=""THENGOSUB1080:GOTO880
1040 GOSUB1100:IFFL<>0ANDS1$<>""THENGOSUB1070:GOTO880
1050 IFFL<>0ANDS1$=""THEN880
1060 PR=1:S1$=S1$+S2$:GOSUB1080:QNS+1GOTO1070:GOTO890
1070 B$(LC)=B$(LC)+S1$+" ":VC=VC+1:PR=0:RETURN
1080 IFS=1THENS=0:RETURN
1090 IFS>1THENS$=RIGHT$(S$,LEN(S$)-1):S=LEN(S$):RETURN
1100 RESTORE:FL=0:FORN=1TOBS:READT$:T=LEN(T$)
1110 IFLEFT$(S$,T)=T$THENFL=T:N=BS
1120 NEXTN:IFFL<>0THENS$=RIGHT$(S$,LEN(S$)-T):S2$=""
1130 S=LEN(S$):RETURN
1140 FORI=LLTOUL-1:FORL=I+1TOUL:IFC(I)>=C(L)THENGOSUB1220
1150 NEXTL,I:RETURN
1160 M=INT(M/2):K=N-M:J=1:IFM=0THENRETURN
1170 I=J
1180 L=I+M:IFC$(I)<=C$(L)THEN1200
1190 GOSUB1220:I=I-M:IFI-1>=0THEN1180
1200 J=J+1:IFJ-K<=0THEN1170
1210 GOTO1160
1220 SWAPC(I),C(L):SWAPC$(I),C$(L):RETURN
1230 DIMC$(VC),C(VC):PC=1:PL=0
1240 PL=PL+1:IFPL>LCTHENRETURN
1250 IFLEN(B$(PL))=0THEN1240
1260 C(PC)=B(PL):T$="":PB=0
1270 PB=PB+1:T$=LEFT$(B$(PL),PB):IFRIGHT$(T$,1)<>" "THEN1270
1280 C$(PC)=T$:PC=PC+1:IFLEN(T$)=LEN(B$(PL))THENB$(PL)="":GOTO1240
1290 B$(PL)=RIGHT$(B$(PL),LEN(B$(PL))-LEN(T$)):GOTO1260
OK
```

The $35 Bare-Bones Microcomputer

Even in these inflationary times, a little dough can go a long way.

Albert Marks
3260 NW 84 Ave.
Fort Lauderdale, FL 33321

This article shows how you can easily build a microcomputer with one of the new one-chip microcomputers on the market today. You don't need an external clock or PROMs. All you need is a single voltage power supply. The I/O ports are provided on-chip for a total of 27 lines. An informative owner's manual is also available from Intel.

The Circuit

The entire microcomputer is contained in seven integrated circuits: 8035 CPU; two 2111 RAMs; 8212 latch; and 7432, 7474 and 7400 chips for control purposes. Except for a few modifications, this circuit is essentially the same circuit recommended by Intel.

The on-board oscillator is a high-gain series-resonant circuit with a frequency range of 1 to 6 MHz. A crystal or inductor connected from pin 2 and pin 3 may be used to provide the clock. The 8035 differentiates between program memory and data memory; therefore, both signals are ORed and used to access RAM.

There are several chips that will expand the basic unit and are designed for the 8035 family:

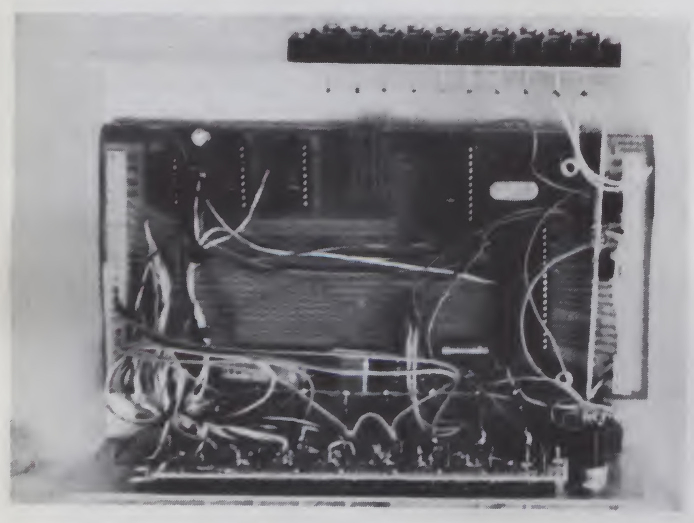

Photo 1. PC board construction.

8253—programmable interval timer 3-16 bit.
8255—programmable peripheral interface.
8243—input/output expander four 4-bit ports.

Construction

My objective was to build a simple learning tool in the easiest and least expensive method. I constructed the project in two weekends for $35, not including chassis. The unit can be built on a perforated breadboard to save the expense of a chassis and most of the metal work. I recommend using sockets to make later changes easy.

Lay out the components on the perforated board as shown in Fig. 1. Use point-to-point wiring. Photo 1 shows that I used a PC board, but it is not worth the extra effort. Mount decoupling capacitors at each socket with short leads.

I prefer the 74LS series of TTL ICs, but most others will work. The limiting resistors used for the LEDs are a compromise between current drain and brightness. Their function is to show whether a line is high or low. If you don't mind uneven brightness, they don't have to be the same value.

I mounted the LEDs on a perfboard and used stand-offs to attach to the front of an 8 × 6 × 3½ inch case used to house the entire unit. A hexadecimal display, such as the TIL311, can be added later. Since debounce is not a problem, use whatever switches you have, but remember to keep it easy to operate. To avoid the need for ROMs and to keep the unit simple, I used front panel loading, as on some large computer systems. There should be no special problems in wiring, but double-check connections and polarity before applying power.

The DMA switch in Photo 2 is an eight-pole-single-throw, available from Poly Paks for $1. I used two four-pole-single-throws.

Programming

The CPU does not have true DMA, and no program is in firmware, so an unorthodox method is used to load a program.

The RAM is manually loaded with the program we want to execute while the CPU is being single-stepped and used as a counter that automatically increments by one with each push of the single-step switch. In this manner, RAM is addressed sequentially starting at zero.

To load a program,

1) set SA to SS.

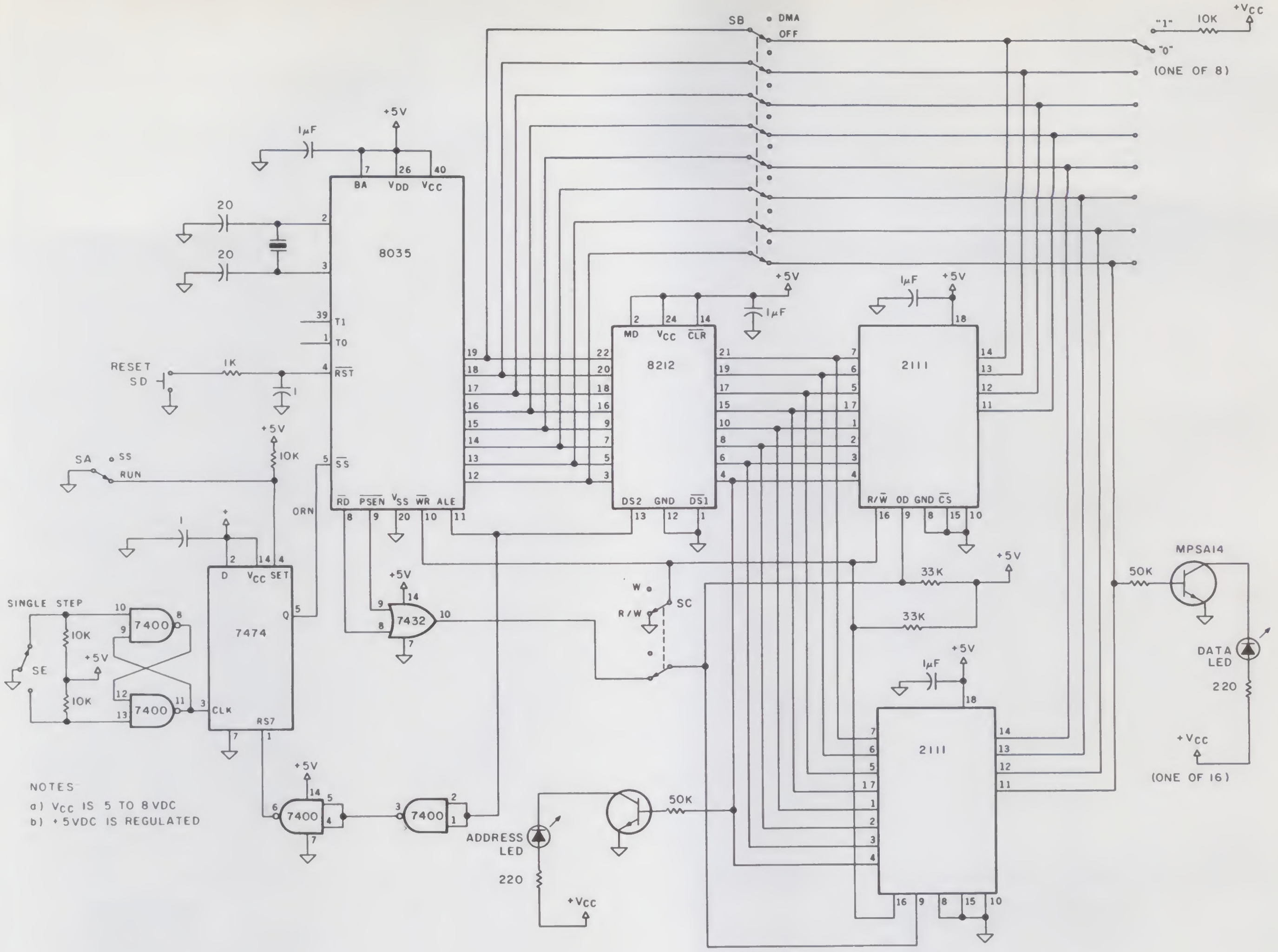

Fig. 1. Complete circuit.

2) set SB to DMA-on.
3) set SC to W (write).
4) push SD (reset).

The RAM is now in a write mode, and the data switches may be used to enter the desired data. The LEDs will show the corresponding address and data present.

5) push SE (single step, single entry).
6) enter new data via data switches.

Repeat steps 5 and 6 until the entire program is loaded into RAM. The next step is to put the CPU, now in RAM, under program control. Data switches are left in position 1.

7) set SC to read.
8) set SB to DMA-off.
9) set SA to run.
10) push SD.

The program entered should now be in control of the CPU.

Background

The processor memory serves as an area to store instructions, the pieces of information that direct the activities of the CPU. A group of logically related instructions stored in memory is referred to as a program. The CPU reads from memory in a logically determined sequence and uses it to initiate processing actions. If the program is coherent and logical, processing the program will produce intelligible and useful results.

The results after processing must be communicated to the outside world through input/output ports. There are 27 lines provided for this:

Port A—pins 12 to 19 (data bus)
Port B—pins 27 to 34
Port C—pins 21 to 24, pins 35 to 38
T1—pin 39
T0—pin 1
RESET—pin 4

Notice that the data bus is also the lower eight bits of the address bus. When ALE goes low, it means that the lower eight address bits are present at that time. The ALE signal is therefore used to strobe an 8212 and capture the lower eight address bits.

The 8035 contains a counter/timer to aid the user in count-

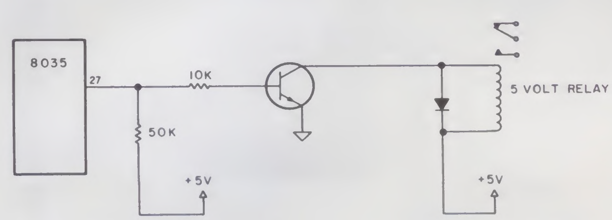

Fig. 2. LED driver circuit. Substitute a relay for the LED and take output from pin 27.

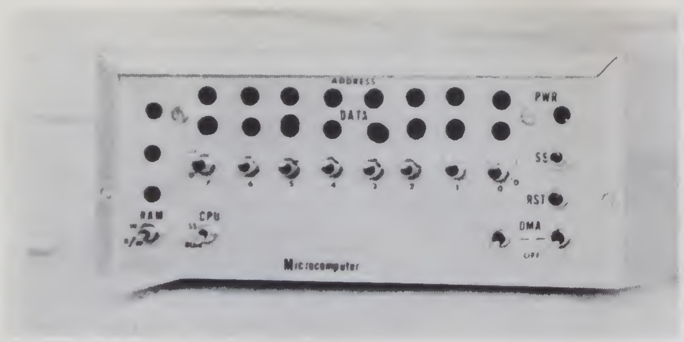

Photo 2. Front panel configuration.

```
A    1001 1001    AND port 1 with zeros
     0000 0000
C    0100 0110    jump to B if T1 is low
     0000 0110
     0000 0100    jump to A
     0000 0000
B    1000 1001    OR port 1 with 1111 1111
     1111 1111
     0100 0110    jump to C
     0000 0010
```

Sample program. Tests the T1 pin 39 and energizes a relay whenever it is held low.

ing external events and generating accurate time delays without placing a burden on the processor for these functions. In both modes the counter operation is the same. The only difference is the source of the input to the counter, which is affected by about eight different instructions and is included on-chip.

An interrupt is initiated by applying a low to pin 6. The program counter and program status word are stored in the stack. Thus, there are three important locations in memory:

Location 0—Activating the reset line causes the first instruction to be fetched from 0.

Location 3—Activating the interrupt line causes a jump to subroutine.

Location 7—A timer/counter interrupt causes a jump to subroutine.

Therefore, the first instruction to be executed is stored in location 0. The first word of an interrupt routine is stored in location 3. The first word of a timer/counter routine is stored in location 7.

The uses to which the microcomputer may be put are only limited by the program written for it. A user may write a first program to read an input from a hexadecimal keyboard for easier entry, to utilize a serial port for TTY or cassette loading or to automatically dial a telephone unattended. The 8035 has a versatile set of instructions and many I/O lines provided on-chip, which make it perfect for control applications. Memory can be expanded by using the four high-order address bits provided on pins 21 to 24.

After you have finished construction, you should purchase the "MCS-48 Microcomputer User's Manual" from Intel Corporation, Santa Clara, CA. This excellent manual ($5) covers all subjects in-depth. Parts of this book have been included and used as a reference source. ■

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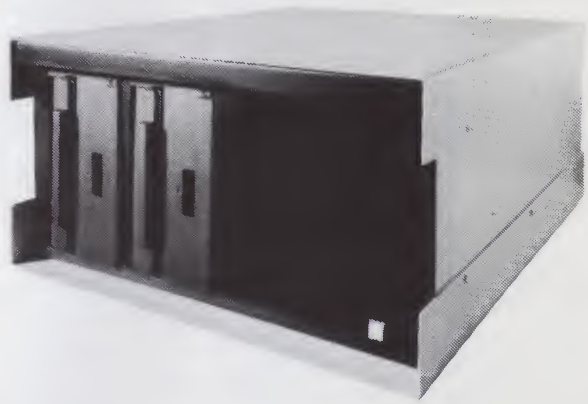

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Thoughts on the SWTP Computer System

The author continues his discussion of the "monitor to end all monitors."

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In this article we will continue our discussion of ROM monitor design and source listings of important routines from my "monitor to end all monitors" called HUMBUG. In part 13 (June 1980) we went over the principal design features, the organization of the monitor and its cold-start procedure. Let's examine the warm-start process.

Warm-Start

MIKBUG has two entry points—E0D0 and E0E3. The entry point at E0D0 initializes everything, whereas entering at E0E3 produces only a restart of the monitor, without full initialization. HUMBUG calls these two entry points cold-start and warm-start. They are actually at FC00 and FC03 in FCROM, but jumps at E0D0 and E0E3 in E0ROM go here too.

FCROM warm-start is shown in Listing 1. As in every entry, the stack pointer is initialized to the monitor stack area at D07F to make sure that the monitor stack never destroys part of the user's stack.

```
                  * WARMSTART INITIALIZATION
FC52 8E D07F   WARMST LDS   #$D07F    SET STACK POINTER TO MONITOR AREA
FC55 4F               CLR A
FC56 B7 D003          STA A DSTAT     TURN OFF D
FC59 B7 D000          STA A POSTAT    TURN OFF PORT 0 OUTPUT
FC5C B7 D004          STA A PASTAT    TURN OFF PAUSE FUNCTION
FC5F 4A               DEC A
FC60 B7 D001          STA A P1STAT    TURN ON CONTROL PORT OUTPUT
FC63 B7 D002          STA A VSTAT     TURN ON VIDEO BOARD OUTPUT
FC66 CE FC03          LDX   #WARMV
FC69 FF D009          STX   RETADD    INITIALIZE PAUSE-RETURN ADDRESS
FC6C 86 0F            LDA A #$0F
FC6E B7 D00D          STA A PAUCTR    INIT PAUSE LINE COUNTER
FC71 CE 8004          LDX   #$8004
FC74 FF A00A          STX   PORADD    SET CONTROL PORT ADDRESS
FC77 86 15            LDA A #$15      ACIA INPUT INITIALIZATION
FC79 B7 D00C          STA A KBDINZ
FC7C 86 11            LDA A #$11      ACIA OUTPUT INITIALIZATION
FC7E B7 D00B          STA A PTRINZ
FC81 86 13            LDA A #$13      TURN READER OFF
FC83 BD FE67          JSR   OUTCHM
FC86 4C               INC A           TURN PUNCH OFF
FC87 BD FE67          JSR   OUTCHM

                * SEE IF OTHER ROMS REQUIRE WARM START INITIALIZATION
FC8A B6 E003          LDA A $E003     CHECK ROM-E0
FC8D 81 7E            CMP A #$7E      IS THERE A JUMP?
FC8F 26 03            BNE   HOTST     NO
FC91 BD E003          JSR   $E003     YES, GO TO IT
```

Listing 1. FCROM warm-start initialization.

The next part of Listing 1 initializes the flags in RAM. First, a zero is stored in DSTAT, P0STAT and PASTAT. DSTAT indicates whether output on the optional port D is desired; a 0 means no. Clearing P0STAT means that output on port 0 is also turned off, while clearing PASTAT disables the pause mode, which pauses output every 15 lines.

Accumulator A is then decremented to FF. This is stored in P1STAT to turn on port 1 output and in VSTAT to turn on video board output. For all of these flags, 00 means off and FF means on.

Next, the address of the warm-start entry point at FC03 is placed into location RETADD. This address is then used whenever a program is stopped with a control-S and aborted with a return. This will normally lead the program back to HUMBUG's warm-start, but any program can modify this location to cause a return to itself. For instance, if BASIC is patched to put 0103 into RETADD, then an abort will go back to BASIC instead. Once control returns back to HUMBUG, this will again be reinitialized to FC03.

The pause counter PAUCTR is then initialized to 15, so that if the pause option is enabled, output will pause every 15 lines. Again, any program could change this to some other value while it is executing.

The next part of warm-start loads 8004, the address of control port 1, into location PORADD. This is compatible with SWTBUG and enables the control port to be moved around by software just by changing the number in location A00A/A00B.

```
                  * HOTST - INITIALIZATION COMPLETE. READY FOR COMMAND
FC94 8E D07F  HOTST  LDS   #$D07F    RESET STACK POINTER TO MONITOR AREA
FC97 7F A00C         CLR   PORECH    TURN ON CONTROL PORT ECHO
FC9A BD FD79         JSR   PCRLF     PRINT CR/LF
FC9D 86 2A           LDA A #'*       PRINT PROMPT
FC9F BD FDFD         JSR   OUTEEE
FCA2 BD FD93         JSR   INEEE     GET FIRST COMMAND CHARACTER
FCA5 36              PSH A           SAVE FIRST CHARACTER OF COMMAND
FCA6 BD FD93         JSR   INEEE     GET SECOND COMMAND CHARACTER
FCA9 16              TAB             MOVE SECOND TO B
FCAA BD FD6B         JSR   OUTS
FCAD 32              PUL A           RESTORE FIRST COMMAND
FCAE 36              PSH A           AND SAVE IT ONCE MORE
              * CHECK COMMAND
FCAF 81 4A           CMP A #'J       CHECK FOR JU(MP)
FCB1 26 07           BNE   NOTJU
FCB3 C1 55           CMP B #'U
FCB5 26 03           BNE   NOTJU
FCB7 7E FD6F         JMP   JUMP      EXECUTE JUMP COMMAND
FCBA 81 4D    NOTJU  CMP A #'M       CHECK FOR ME(MORY CHANGE)
FCBC 26 04           BNE   HOTEND
FCBE C1 45           CMP B #'E
FCC0 27 0F           BEQ   CHANGE    EXECUTE CHANGE COMMAND
              * SEE IF OTHER ROMS HAVE COMMANDS
FCC2 B6 E006  HOTEND LDA A $E006
FCC5 81 7E           CMP A #$7E      IS THERE A JUMP
FCC7 27 02           BEQ   GOJUMP
FCC9 20 C9           BRA   HOTST     AND LOOK FOR MORE
FCCB 32       GOJUMP PUL A           GET FIRST CHARACTER
FCCC BD E006         JSR   $E006     AND JUMP TO NEXT ROM
FCCF 20 C3    GOHOT1 BRA   HOTST     THEN DO MORE COMMANDS
```

Listing 2. FCROM hot-start initialization.

```
E006 7E E20F  COMMDV JMP   COMAND    COMMAND ENTRY POINT

E20F 36       COMAND PSH A           SAVE FIRST CHARACTER
E210 CE E240         LDX   #COMTAB-4 GET ADDR OF COMMAND TABLE
E213 08       LOOKUP INX
E214 08              INX
E215 08              INX
E216 08              INX
E217 8C E278         CPX   #TABEND   END OF TABLE?
E21A 27 10           BEQ   COMEND    YES
E21C A1 00           CMP A 0,X       NO, CHECK FIRST CHARACTER
E21E 26 F3           BNE   LOOKUP    WRONG
E220 E1 01           CMP B 1,X       CHECK SECOND CHARACTER
E222 26 EF           BNE   LOOKUP    WRONG, SKIP TO NEXT
E224 EE 02           LDX   2,X       GET ADDRESS IF OK
E226 32              PUL A           RESTORE STACK
E227 BD FC30         JSR   OUTS      PRINT A SPACE
E22A 6E 00           JMP   0,X       JUMP TO APPROPRIATE COMMAND ROUTINE
              * COMMAND NOT FOUND; SEE IF OTHER ROMS HAVE COMMANDS
E22C B6 E406  COMEND LDA A $E406     CHECK NEXT ROM
E22F 81 7E           CMP A #$7E      IS THERE A JUMP
E231 27 09           BEQ   COMND4
E233 B6 E806         LDA A $E806     CHECK ROM AFTER THAT
E236 81 7E           CMP A #$7E      IS THERE A JUMP
E238 27 06           BEQ   COMND8
E23A 32              PUL A           NO MORE ROMS; FIX UP STACK
E23B 39              RTS             AND RETURN TO FCROM
E23C 32       COMND4 PUL A           NEXT ROM EXISTS; RESTORE FIRST CHARACTER
E23D 7E E406         JMP   $E406     GO TO IT
E240 32       COMND8 PUL A           SECOND ROM EXISTS; RESTORE FIRST CHARACTER
E241 7E E806         JMP   $E806     GO TO IT

              * COMMAND TABLE

E244 4C       COMTAB FCC   'LO' LOAD MIKBUG TAPE
E246 E0 0C           FDD   LOAD
E248 50              FCC   'PU' PUNCH MIKBUG TAPE
E24A E1 18           FDB   PUNCH
E24C 46              FCC   'FD' FLEX DISK BOOT
E24E E2 BE           FDB   FLBOOT
E250 45              FCC   'EN' END OF TAPE FORMATTING
E252 E1 F9           FDB   PNCHS9
E254 47              FCC   'GO' GO TO USER PROGRAM VIA A048/9
E256 E1 A8           FDD   GOTO
E258 43              FCC   'CL' CLEAR SCREEN
E25A E0 58           FDB   CLEAR
E25C 46              FCC   'FI' FIND BYTES COMMAND
E25E E3 05           FDB   FIND
E260 48              FCC   'HD' HEX DUMP ROUTINE
E262 E0 D3           FDB   HEXDMP
E264 46              FCC   'FM' FILL MEMORY
E266 E3 81           FDB   FILL
E268 50              FCC   'PD' PERCOM DISK DOS-PLUS
E26A C0 00           FDB   MDOSPL
E26C 43              FCC   'CS' TWO-BYTE CHECKSUM
E26E E3 9A           FDB   SUM
E270 4D              FCC   'MT' MEMORY TEST
E272 E3 BA           FDB   ROBIT
E274 50              FCC   'PC' PRINT A048/A049
E276 E0 9F           FDB   PRNT48
   (E278)     TABEND EQU   *
```

Listing 3. E0ROM command lookup.

The next four lines overcome the following problem in SWTBUG: each time SWTBUG inputs via INEEE, it initializes the ACIA to use only one stop bit; when doing an output via OUTEEE, it initializes the ACIA to output two stop bits. Unfortunately, if the user has previously initialized the ACIA in some other way, then this will reinitialize the port and destroy what has been done. This has been a particular problem in controlling the reader control line in the interface. HUMBUG does the same thing but puts the two initialization constants into locations KBDINZ and PTRINZ during warm-start and reads them out of these two locations in INEEE and OUTEEE, respectively.

Changing these locations before use allows complete user control over the ACIA. For instance, by changing the two constants from 15 and 11 to 16 and 12, the ACIA will change its baud rate to a quarter of its previous value. Since I have both a 1200 baud terminal and a 300 baud keyboard on the same port, I can change the baud rate from 1200 to 300 and back from the keyboard.

The last four steps of warm-start output $13 and $14 to the port to turn off the reader and punch, if they are controlled by ASCII codes.

Once all FCROM initialization is completed, the program tests to see whether there is a ROM at E000, and a JSR is made to it if it is there. As it turns out, neither E0ROM nor E4ROM require any, so they return to FCROM with an RTS. Their handling of warm-start is identical with that of cold-start, so I'm not including those listings here.

Hot-Start

Hot-start is my name for the command loop that looks for monitor commands and goes to execute them. The FCROM hot-start routine is shown in Listing 2.

As usual, the stack pointer is first reset to the monitor stack area at D07F. Then location PORECH is zeroed (it is used by INEEE to determine whether to echo keyboard input). In this one case, 00 means that echo is on and FF means that it is off. This is the opposite of the other flags, but is necessary to be compatible with SWTBUG. The program then jumps to a carriage-return/line-feed subroutine and outputs the prompt character (*). It then inputs the two-letter command, puts the two letters into the two accumulators and checks them.

Since FCROM has only two commands, it is much faster to check the letters directly than to look them up in a command table. If the command is JU, then we jump to routine JUMP; if the command is ME, then we jump to routine CHANGE.

However, if the command is not recognized, then FCROM checks to see whether there is another ROM at E000. If so, it executes a JSR to the hot-start entry point of that ROM, carrying the two-letter command in accumulators A and B. If the command is not recognized by the other ROMs, they execute an RTS to return to the last line in Listing 2, which will return back to the beginning of the hot-start command loop. In this way, the command routine of all other ROMs (except FCROM) can be called as a subroutine by user programs.

Each of the other ROMs has more than two possible commands, so to more efficiently recognize the two-letter command, we should look it up in a table. Listing 3 shows how E0ROM does this; all other ROMs are done the same way.

In each case, there is a command table, COMTAB, which lists each two-letter command, followed by the address of the routine that executes that command. The program simply looks through that table—one entry at a time—and tries to match up the two letters in the A and B accumulators against the command entry in the table. If a match is found, then the program executes an indexed jump to the address listed in the table.

If no match is found, the routine checks whether there are any other ROMs. For instance, E0ROM checks for ROMs at E400 and E800, etc. If any are found, the program jumps to their command entry point; if not, then an RTS returns the pro-

```
              * JUMP TO USER PROGRAM COMMAND
FD6F 8D A5    JUMP   BSR   BADDR     GET ADDRESS
FD71 8E A07F         LDS   #$A07F    INITIALIZE STACK TO USER AREA
FD74 AD 00           JSR   0,X       JUMP TO USER PROGRAM
FD76 7E FC52         JMP   WARMST    ON RTS, RETURN TO WARM START
```

Listing 4. JU command.

gram to FCROM without doing anything.

Back to FCROM

FCROM has all of the MIKBUG-compatible routines such as INHEX, BADDR and OUT2HS, as well as routines to change memory and jump to a user program. All of these are identical to MIKBUG (except that references to a PIA on port 1 have been changed to an ACIA). Only three routines—the jump-to-user-program routine, INEEE and OUTEEE—are substantially different.

Jump to User Program

As shown in Listing 4, the routine JUMP consists of just four steps. First, routine BADDR is called to get the jump address. Then the stack pointer is set to A07F, the user stack area, and JSR is executed to the address that has been input by BADDR and held in the index register.

This instruction is JSR rather than JMP so that subroutines can be executed and tested. A return to warm-start follows JSR so that when a subroutine returns to the monitor, it will neatly reenter the monitor.

Notice how a completely different user stack area—separate from the monitor stack at D07F—is set up. No locations in the scratchpad RAM at A000–A07F are used other than what SWTBUG used. The user program can thus redefine the stack area to a location compatible with SWTBUG or MIKBUG. On the other hand, if the user program does not redefine the stack, then a large area of the scratchpad is available for stack use.

INEEE

The new INEEE is shown in Listing 5. The last dozen lines of INEEE are the heart of the routine. INCH8 checks the ACIA on the control port for a character, waits for it if none is there and then returns to the calling routine with the character in the A accumulator. Note how PORADD is used to define the port address, while KBDINZ is used to configure it just before the input.

INCH8 returns a full 8-bit character, including the parity bit, which is required for some routines. However, most of the time, we want to strip off the parity bit and make the first bit of each character a 0. This is done by INCH7, which ANDs the character from INCH8 with a mask of $7F (a binary 01111111) to remove the first bit.

INEEE starts with saving the B accumulator and index register and then gets the character from INCH7. If it is not a control-S (or an ASCII $13), then it tests PORECH to see whether echoing is desired and prints it back via OUTEEE if PORECH is equal to 00.

If a control-S was detected, INEEE jumps to GOTCS and then to GETCMD to get the next character and perform the indicated command.

GETCMD starts by ringing the bell to signal that it is in control and then gets the next character

```
              * INEEE - CHARACTER INPUT ROUTINE
FD93 37       INEEE  PSH B             SAVE B
FD94 FF D005         STX   INEEXR      SAVE REGISTERS
FD97 8D 4F    INRPT  BSR   INCH7       GET INPUT CHARACTER
FD99 81 13           CMP A #$13        IS IT CONTROL-S?
FD9B 27 0C           BEQ   GOTCS       YES
FD9D 7D A00C         TST   PORECH      NO; ECHO ON?
FDA0 26 02           BNE   INEXIT      NO, SO EXIT
FDA2 8D 59           BSR   OUTEEE      YES, SO ECHO
FDA4 FE D005  INEXIT LDX   INEEXR      RESTORE REGISTERS
FDA7 33              PUL B
FDA8 39              RTS               AND RETURN

              * CONTROL-S DETECTED. GET AND INTERPRET COMMAND
FDA9 8D 02    GOTCS  BSR   GETCMD      DO COMMAND
FDAB 20 EA           BRA   INRPT

              * SUBROUTINE TO GET AND DO COMMAND
FDAD 86 07    GETCMD LDA A #$07
FDAF BD FE67         JSR   OUTCHM      ECHO CONTROL-G (BELL) ON CTL PORT
FDB2 8D 34           BSR   INCH7       GET SECOND CHARACTER OF CMD
FDB4 81 30           CMP A #'0         PORT 0 COMMAND?
FDB6 26 04           BNE   NOT0        NO
FDB8 73 D000         COM   P0STAT      YES; FLIP PORT 0 STATUS
FDBB 39              RTS               AND RETURN
FDBC 81 31    NOT0   CMP A #'1         PORT 1 COMMAND?
FDBE 26 04           BNE   NOT1        NO
FDC0 73 D001         COM   P1STAT      YES; FLIP PORT 1 STATUS
FDC3 39              RTS
FDC4 81 44    NOT1   CMP A #'D         PORT D COMMAND?
FDC6 26 04           BNE   NOTD        NO
FDC8 73 D003         COM   DSTAT       YES; FLIP PORT D STATUS
FDCB 39              RTS
FDCC 81 50    NOTD   CMP A #'P         PAUSE COMMAND?
FDCE 26 09           BNE   NOTP        NO
FDD0 73 D004         COM   PASTAT      YES; FLIP PAUSE STATUS
FDD3 86 0F           LDA A #$F
FDD5 B7 D00D         STA A PAUCTR      RESET PAUSE LINE CNTR
FDD8 39              RTS               AND RETURN
FDD9 81 0D    NOTP   CMP A #$0D        CR COMMAND TO QUIT?
FDDB 26 0A           BNE   NOTCR       NO
FDDD 33              PUL B             YES; FIX UP STACK
FDDE 33              PUL B
FDDF 33       QUIT   PUL B             RESTORE B
FDE0 32              PUL A
FDE1 32              PUL A             FIX STACK SOME MORE
FDE2 FE D009         LDX   RETADD      GET RETURN ADDRESS
FDE5 6E 00           JMP   0,X         AND RETURN
FDE7 39       NOTCR  RTS               RETURN WITHOUT DOING ANYTHING OTHERWISE

              * ACTUAL CONTROL PORT INPUT ROUTINES
FDE8 8D 03    INCH7  BSR   INCH8       GET 7-BIT CHARACTER
FDEA 84 7F           AND A #$7F        MASK OUT PARITY
FDEC 39              RTS
FDED FE A00A  INCH8  LDX   PORADD      GET 8-BIT CHARACTER
FDF0 B6 D00C         LDA A KBDINZ      CONFIGURE ACIA
FDF3 A7 00           STA A 0,X
FDF5 A6 00    ACIAIN LDA A 0,X
FDF7 47              ASR A
FDF8 24 FB           BCC   ACIAIN      WAIT FOR CHARACTER
FDFA A6 01           LDA A 1,X         GET IT
FDFC 39              RTS               AND RETURN
```

Listing 5. INEEE routine.

via INCH7. If this character is either 0, 1, D or P, then it toggles P0STAT, P1STAT, DSTAT or PASTAT, respectively. Complementing is used, so that these flags will go from 00 to FF and back to 00 each time they are flipped. These four flags control output on port 0, port 1, optional port D and the pause mode. On a valid command, GETCMD ends with RTS, which goes back to GOTCS, which, in turn, leads back to INRPT to read the next character. Thus, the character following the control-S is neither echoed nor returned to the calling program.

On the other hand, if the character following the control-S was a carriage return, then the GETCMD fetches the return address from RETADD and jumps to it, thereby aborting whatever program had called it.

OUTEEE

Listing 6 shows the revised OUTEEE. This routine begins by saving some of the registers and then checks the control port for the presence of any character at the keyboard. If it detects a control-S, then it goes to GETCMD to execute it (as I described previously). Any other condition leads to NOTEST.

The next few steps check PASTAT to see whether the pause mode is on. If it is, then a series of decisions has to be made. If the current character is a clear-screen character (hex 10 or control-P in SWTP programs and terminals), then the pause line counter must be reset to allow a full screen after the clear-screen command is executed. Next, if the current character is a carriage return, then the line counter PAUCTR is decremented and checked to see if it is time to pause. If it is, then the program resets the pause line counter back to 15 (hex 0F) and waits for any character from the keyboard. If this character is another carriage return, then the program aborts; otherwise, it continues.

After all pause processing is over, OUTEEE checks each of the port flags (P0STAT, P1STAT, VSTAT and DSTAT). If any of these are nonzero, then the current character is output via that port. Note how VSTAT controls video board output. Although there is no monitor routine to control this flag (other than its being initialized), VSTAT allows other programs to turn off the video board—instead of straight echoing of OUTEEE

```
                  * OUTEEE - CHARACTER OUTPUT ROUTINE
FDFD 37           OUTEEE PSH B             SAVE B
FDFE FF D007             STX   OUTEXR      SAVE XR
FE01 36                  PSH A             SAVE CHARACTER
FE02 FE A00A             LDX   PORADD
FE05 A6 00               LDA A 0,X         CHECK CONTROL PORT
FE07 47                  ASR A
FE08 24 0A               BCC   NOTEST      NO CHARACTER
FE0A A6 01               LDA A 1,X         CHARACTER; GET IT
FE0C 84 7F               AND A #$7F        MASK OUT PARITY BIT
FE0E 81 13               CMP A #$13        IS IT CONTROL-S?
FE10 26 02               BNE   NOTEST      NO
FE12 8D 99               BSR   GETCMD      YES; GET COMMAND AND DO IT
FE14 32           NOTEST PUL A             FINISHED TESTING FOR COMMAND
                  * CHECK FOR PAUSE
FE15 7D D004             TST   PASTAT      PAUSE STATUS ON?
FE18 27 24               BEQ   NOPAUS      NO
FE1A 81 10               CMP A #$10        CLEAR SCREEN?
FE1C 26 07               BNE   NOCLR       NO
FE1E 86 0F               LDA A #$0F        YES; RESET PAUSE COUNTER
FE20 B7 D00B             STA A PAUCTR
FE23 20 19               BRA   NOPAUS
FE25 81 0D        NOCLR  CMP A #$0D        CR?
FE27 26 15               BNE   NOPAUS      ONLY PAUSE AT END OF LINE
FE29 7A D00D             DEC   PAUCTR      DECR PAUSE LINE CNTR
FE2C 26 10               BNE   NOPAUS      AND CHECK IT
FE2E 86 0F               LDA A #$0F        MUST PAUSE. RESET CNTR
FE30 B7 D00D             STA A PAUCTR
FE33 8D B3               BSR   INCH7       WAIT FOR RESTART CHAR
FE35 81 0D               CMP A #$0D        QUIT IF IT'S A CR
FE37 26 03               BNE   PCONT
FE39 7E FDDF             JMP   QUIT
FE3C 86 0D        PCONT  LDA A #$0D        CONTINUE WITH CR
FE3E 7D D000      NOPAUS TST   P0STAT      PRINT ON PORT 0?
FE41 27 02               BEQ   NOTPT0      NO
FE43 8D 1D               BSR   OUTCH0      YES
FE45 7D D001      NOTPT0 TST   P1STAT      PRINT ON CONTROL PORT?
FE48 27 02               BEQ   NOTPTM      NO
FE4A 8D 1D               BSR   OUTCHM      YES
FE4C 7D D002      NOTPTM TST   VSTAT       OUTPUT VIA VIDEO BOARD?
FE4F 27 04               BEQ   NOTVID      NO
FE51 36                  PSH A             YES
FE52 8D 24               BSR   OUTCHV      OUTPUT ON VIDEO
FE54 32                  PUL A
FE55 7D D003      NOTVID TST   DSTAT       PRINT ON D?
FE58 27 03               BEQ   NOTDUR      NO
FE5A BD EC0C             JSR   OUTCHD      YES
FE5D FE D007      NOTDUR LDX   OUTEXR      RELOAD XR AND B
FE60 33                  PUL B
FE61 39                  RTS

                  * OUTPUT ON PORT 0
FE62 CE 8000      OUTCH0 LDX   #$8000      OUTPUT TO PORT 0
FE65 20 03               BRA   OUTCHE

                  * OUTPUT ON CONTROL PORT
FE67 FE A00A      OUTCHM LDX   PORADD
FE6A F6 D00B      OUTCHE LDA B PTRINZ      ACIA INITIALIZATION
FE6D E7 00               STA B 0,X         INITIALIZE FOR 8 BITS, 2 SB
FE6F E6 00        OUTM2  LDA B 0,X         WAIT UNTIL READY
FE71 57                  ASR B
FE72 57                  ASR B
FE73 24 FA               BCC   OUTM2
FE75 A7 01               STA A 1,X         PRINT IT
FE77 39                  RTS
```

Listing 6. OUTEEE routine.

```
E009 7E E278  FRMTOV JMP   FROMTO    FROMT-TO SUBROUTINE ENTRY

              * FROMTO SUBROUTINE - INITIALIZE BEGA AND ENDA ADDRESSES

E278 CE E04A  FROMTO LDX   #FROMST
E27B BD FC12         JSR   PDATA     PRINT "FROM "
E27E BD FC09         JSR   INEEE     GET CHARACTER
E281 81 0D           CMP A #$0D      IS IT A CR?
E283 26 03           BNE   GETFT     CONTINUE IF NOT
E285 7E FC0F         JMP   CRLF      ON CR, DO CRLF AND RETURN
E288 80 30    GETFT  SUB A #$30      CONTINUE .. CHECK FOR DIGIT
E28A 2B 2F           BMI   GOHOTS    NOT HEX
E28C 81 09           CMP A #$9
E28E 2F 0A           BLE   GOTONE
E290 81 11           CMP A #$11
E292 2B 27           BMI   GOHOTS    NOT HEX
E294 81 16           CMP A #$16
E296 2E 23           BGT   GOHOTS    NOT HEX
E298 80 07           SUB A #7        CONVERT A-F TO NUMBER
E29A 48       GOTONE ASL A           GOT FIRST DIGIT
E29B 48              ASL A
E29C 48              ASL A
E29D 48              ASL A
E29E 16              TAB             TEMP SAVE IT
E29F BD FC18         JSR   INHEX     GET SECOND DIGIT
E2A2 1B              ABA             COMBINE THEM
E2A3 B7 A002         STA A BEGA      STORE LEFT TWO DIGITS
E2A6 BD FC1B         JSR   BYTE      GET NEXT TWO
E2A9 B7 A003         STA A BEGA+1    STORE RIGHT TWO AS FROM ADDRESS
E2AC CE E06E         LDX   #TOSTR
E2AF BD FC12         JSR   PDATA     PRINT "TO "
E2B2 BD FC1E         JSR   BADDR     GET TO ADDRESS
E2B5 FF A004         STX   ENDA      STORE IT
E2B8 7E FC30         JMP   OUTS
E2BB 31       GOHOTS INS             INVALID DIGIT; INCREMENT SP TO BYPASS
E2BC 31              INS             ...THE CALLING ROUTINE AND RETURN ONE LEVEL
E2BD 39              RTS             ...ABOVE (TO HOTSTART)
```

Listing 7. FROMTO routine.

```
              * 'HD' HEX DUMP COMMAND

E0D3 BD E278  HEXDMP JSR   FROMTO
E0D6 FE A002         LDX   BEGA      GET STARTING ADDRESS
E0D9 FF D020         STX   SAVEX     SAVE DUPLICATE
E0DC 20 08           BRA   HEXCON    AND SKIP OVER NEXT VECTOR

              * FREE TO E0E2 (5)

              * WARMST WARM START
  (E0E3)             ORG   $E0E3
E0E3 7E FC03  E0E3   JMP   WARMST    VECTOR TO FC ROM

              * CONTINUATION OF HEX DUMP
E0E6 B6 D021  HEXCON LDA A SAVEX+1
E0E9 84 F0           AND A #$F0      ROUND DOWN TO NEXT 0
E0EB B7 D021         STA A SAVEX+1
E0EE BD FC0F  HEX    JSR   CRLF
E0F1 CE D020         LDX   #SAVEX    GET LOCATION OF STARTING ADDR
E0F4 BD FC2D         JSR   OUT4HS    PRINT IT
E0F7 BD FC30         JSR   OUTS      EXTRA SPACE
E0FA C6 10           LDA B #16       SET COUNTER TO 16
E0FC FE D020         LDX   SAVEX
E0FF BD FC2A  HEX1   JSR   OUT2HS    PRINT NEXT BYTE
E102 09              DEX             BACKUP POINTER
E103 BC A004         CPX   ENDA      LAST ADDRESS?
E106 26 01           BNE   HEX2      CONTINUE IF NOT
E108 39              RTS             OTHERWISE END
E109 08       HEX2   INX             RESTORE POINTER
E10A 5A              DEC B           DECREMENT COUNTER
E10B 26 F2           BNE   HEX1      CONTINUE LINE IF NOT FINISHED
E10D FF D020         STX   SAVEX     SAVE CURRENT POINTER
E110 20 DC           BRA   HEX       GET READY FOR NEXT LINE
```

Listing 8. Hex dump routine.

output—whenever memory-mapped output or graphics are desired.

OUTCH0 and OUTCHM are two character output routines that output to port 0 and the control port, respectively. The actual port address used depends simply on the address loaded into the index register.

FROMTO Subroutine

MIKBUG's P, or Punch, routine used locations BEGA (A002-3) and ENDA (A004-5) to hold the beginning and ending addresses of memory to be punched to tape. In a similar way, HUMBUG uses these same two locations, not just for the PU command, but for other commands as well. The FROMTO subroutine in Listing 7 is used by these commands to ask for these two addresses from the control port.

This routine is easy to understand but has two special operating modes. After INEEE is called for the first digit of the "from" address in the third line, that character is checked for a carriage-return character. If a CR is detected, then the routine returns to the calling program without changing BEGA and ENDA. Next, even if this character is not a return, if it is not a valid hex digit, then the subroutine returns to the program one level above the calling program; that is, it returns to the program that called the program that called FROMTO. In the case of these monitor routines, this will always mean a return to the hot-start location.

Although FROMTO is buried in E0ROM, there is an entry vector to it in location E009, so that its calling address does not change even if E0ROM is modified.

Monitor Commands

Except for the ME and JU commands in FCROM, all other commands are subroutines that

```
E305 CE E0AD  FIND   LDX    #MANYST
E308 BD FC12         JSR    PDATA     ASK "HOW MANY BYTES"
E30B BD FC09         JSR    INEEE     GET NUMBER
E30E 80 30           SUB A  #$30      CONVERT FROM ASCII
E310 27 6C           BEQ    FIND5     IF = 0
E312 2B 6A           BMI    FIND5     IF LESS THAN 0
E314 81 03           CMP A  #$3
E316 2E 66           BGT    FIND5     IF GREATER THAN 3
E318 B7 D025         STA A  FINDNO    STORE NUMBER OF BYTES
E31B BD FC30         JSR    OUTS
E31E CE E1EA         LDX    #WHATST
E321 BD FC12         JSR    PDATA     ASK "WHAT BYTES"
E324 F6 D025         LDA B  FINDNO    GET NUMBER
E327 CE D022         LDX    #WHAT
E32A 37       FIENTR PSH B
E32B BD FC1B         JSR    BYTE      ENTER A BYTE
E32E 33              PUL B            RESTORE COUNTER
E32F A7 00           STA A  0,X       STORE IT
E331 08              INX
E332 5A              DEC B
E333 26 F5           BNE    FIENTR    ENTER MORE, IF NEEDED
E335 BD E278         JSR    FROMTO    GET BEGA AND ENDA
E338 FE A002         LDX    BEGA      GET READY TO LOOK
E33B F6 D025  FIND1  LDA B  FINDNO    MAIN FIND LOOP
E33E A6 00           LDA A  0,X       GET FIRST BYTE
E340 B1 D022         CMP A  WHAT
E343 26 31           BNE    FIND4     WRONG BYTE
E345 5A              DEC B
E346 27 11           BEQ    FIND2     FOUND ONE CORRECT BYTE
E348 A6 01           LDA A  1,X       GET SECOND BYTE
E34A B1 D023         CMP A  WHAT+1
E34D 26 27           BNE    FIND4     WRONG
E34F 5A              DEC B
E350 27 07           BEQ    FIND2     FOUND TWO CORRECT BYTES
E352 A6 02           LDA A  2,X       GET THIRD BYTE
E354 B1 D024         CMP A  WHAT+2
E357 26 1D           BNE    FIND4     WRONG BYTE
E359 FF D020  FIND2  STX    SAVEX     FOUND CORRECT BYTES
E35C 8D 20           BSR    FIND5     PRINT CRLF VIA VECTOR AT FIND5
E35E CE D020         LDX    #SAVEX    POINT TO ADDRESS WHERE FOUND
E361 BD FC2D         JSR    OUT4HS    PRINT IT
E364 BD FC30         JSR    OUTS      ONE MORE SPACE
E367 FE D020         LDX    SAVEX
E36A 09              DEX              BACKUP ONE BYTE
E36B C6 04           LDA B  #4        READY TO PRINT FOUR BYTES
E36D BD FC2A  FIND3  JSR    OUT2HS    PRINT BYTE
E370 5A              DEC B
E371 26 FA           BNE    FIND3     PRINT FOUR BYTES
E373 FE D020         LDX    SAVEX     RESTORE INDEX REGISTER
E376 BC A004  FIND4  CPX    ENDA      SEE IF DONE
E379 27 03           BEQ    FIND5     YES
E37B 08              INX              NO
E37C 20 BD           BRA    FIND1     KEEP LOOKING
E37E 7E FC0F  FIND5  JMP    CRLF      DO LAST CRLF AND RETURN TO FCROM WHEN DONE
```

Listing 9. Find routine.

normally return to the hot-start entry point and are also user callable. Some of them are to the point, such as PU and LO, which are similar to MIKBUG's P and L routines, except for the use of an ACIA instead of a PIA.

Let's look at the other routines.

Listing 8 shows the HEXDMP routine. As with several other routines in E0ROM, this one is sandwiched between MIKBUG-compatible calls. In this case, the monitor restart vector at E0E3 splits it in two parts.

This listing shows how FROMTO is called at the beginning to allow beginning and ending addresses to be specified. The beginning address is moved from BEGA to temporary location SAVEX, but the second byte of that address is ANDed with $F0 to force the last digit to always be 0. Thus, the 16 bytes printed on a line will always start with a location ending with 0.

Subroutines to perform the FI (find), FM (fill memory), CS (checksum memory), AI (ASCII input), AO (ASCII output) and MO (move memory) commands are shown in Listings 9 through 14, respectively. Most of these are easily understandable.

Note how the move memory routine checks the old and new addresses to see whether memory contents are being moved to lower or higher addresses. This is necessary to avoid erasing data if the new locations overlap the old locations. If the memory contents are being moved to lower addresses, then the move starts with the lower address. But if the move is to higher addresses, then the highest locations are moved first. In this way, even if the old and new locations overlap, data will be moved out of the way before it is written over.

The routine for the DE, or "DEsemble," command is shown in Listing 15. It consists of a short calling program named DESEMB and a subroutine called PRNTOP, which does most of the work.

DESEMB begins by calling

```
                    * "FM" COMMAND - FILL MEMORY WITH CONSTANT

E381 BD E278  FILL   JSR   FROMTO    GET FROM-TO ADDRESSES
E384 CE E1C5         LDX   #WITHST
E387 BD FC12         JSR   PDATA     ASK FOR DATA
E38A BD FC1B         JSR   BYTE
E38D FE A002         LDX   BEGA      GET STARTING ADDRESS
E390 09              DEX
E391 08       FILOOP INX
E392 A7 00           STA A 0,X       STORE THE BYTE
E394 BC A004         CPX   ENDA      SEE IF DONE
E397 26 F8           BNE   FILOOP    CONTINUE OF NO
E399 39              RTS             QUIT WHEN DONE
```

Listing 10. Fill memory routine.

```
              * SUM - MEMORY CHECKSUM

E39A BD E278  SUM    JSR   FROMTO    GET ADDRESS LIMITS
E39D FE A002         LDX   BEGA      GET STARTING ADDRESS
E3A0 4F              CLR A
E3A1 5F              CLR B
E3A2 EB 00    SUMLP  ADD B 0,X       ADD TO CHECKSUM
E3A4 89 00           ADC A #0        ALSO ADD CARRY TO SECOND BYTE
E3A6 BC A004         CPX   ENDA      LAST ADDRESS?
E3A9 27 03           BEQ   SUMDON    YES
E3AB 08              INX             NO, SO INCREMENT AND
E3AC 20 F4           BRA   SUMLP
E3AE B7 D020  SUMDON STA A SAVEX     STORE SUM WHEN DONE
E3B1 F7 D021         STA B SAVEX+1
E3B4 CE D020         LDX   #SAVEX    POINT TO CHECKSUM
E3B7 7E FC2D  VEC4HS JMP   OUT4HS    OUTPUT CHECKSUM AND RETURN WHEN DOZL
```

Listing 11. Checksum routine.

```
                  * 'AI' COMMAND - ASCII INPUT ROUTINE

E525 BD E009  ASCIN  JSR   FROMTO    GET ADDRESS RANGE
E528 BD FC0F         JSR   CRLF
E52B FE A004         LBX   ENDA      GET LAST EMPTY ADDRESS
E52E FF D02C         STX   SAVEX     SAVE IT
E531 FE A002         LDX   BEGA      GET STARTING ADDRESS
E534 09              DEX
E535 08       ASCI2  INX
E536 BD FC09         JSR   INEEE     GET NEXT CHARACTER
E539 A7 00           STA A 0,X       STORE IT
E53B A1 00           CMP A 0,X       SEE IF IT STORED OK
E53D 26 08           BNE   ASCI3
E53F FF A004         STX   ENDA      STORE ENDING ADDRESS
E542 BC D02C         CPX   SAVEX     CHECK IF RUN OUT OF MEMORY
E545 26 EE           BNE   ASCI2     NO, SO GET MORE
E547 CE E54F  ASCI3  LDX   #ESTR     MEM FULL OR BAD, SO..
E54A BD FC12         JSR   PDATA     PRINT ERROR
E54D 20 F8           DRA   ASCI3     GO TO REPEAT

E54F 20       ESTR   FCB      ,'E, R,'R,'O,'R,4
```

Listing 12. ASCII input routine.

```
                  * 'AO' COMMAND - ASCII OUTPUT ROUTINE

E556 BD E009  ASCOUT JSR   FROMTO    GET ADDRESS RANGE
E559 BD FC0F         JSR   CRLF
E55C FE A002         LDX   BEGA      GET STARTING ADDRESS
E55F A6 00    ASCO2  LDA A 0,X       GET NEXT CHARACTER
E561 BD FC0C         JSR   OUTEEE    OUTPUT IT
E564 BC A004         CPX   ENDA      SEE IF DONE
E567 27 03           BEQ   ASCO3     YES
E569 08              INX
E56A 20 F3           BRA   ASCO2     REPEAT IF NOT
E56C 39       ASCO3  RTS             RETURN WHEN DONE
```

Listing 14. Move routine.

```
E56D 45       OLDSTR FCC   'ENTER OLD ADDRESSES:'
E581 04              FCB   4
E582 45       NEWSTR FCC   'ENTER NEW ADDRESS:  '
E596 04              FCB   4
E597 CE E56D  MOVE   LDX   #OLDSTR
E59A BD FC12         JSR   PDATA     ASK FOR OLD ADDRESSES
E59D BD E009         JSR   FROMTO
E5A0 BD FC0F         JSR   CRLF
E5A3 CE E582         LDX   #NEWSTR
E5A6 BD FC12         JSR   PDATA     ASK FOR NEW ADDRESS
E5A9 BD FC1E         JSR   BADDR
E5AC FF D042         STX   NEWLOC    SAVE
              * NOW CHECK FOR FORWARD MOVE OR BACKWARD MOVE
E5AF D6 A002         LDA A BEGA
E5B2 B0 D042         SUB A NEWLOC
E5B5 25 2E           BCS   BACK      IF NEW>OLD
E5B7 26 0B           BNE   FORWRD    IF <>
E5B9 B6 A003         LDA A BEGA+1    IF =, CHECK THE REST
E5DC B0 D043         SUD A NEWLOC+1
E5BF 25 24           BCS   BACK      IF NEW>OLD
E5C1 26 01           BNE   FORWRD
E5C3 39       MEXIT  RTS             NO MOVE IF NEW=OLD
              * FORWARD MOVE
E5C4 FE A002  FORWRD LDX   BEGA
E5C7 FF D02C         STX   SAVEX     SAVE COPY OF STARTING ADDRESS
E5CA FE D02C  FWD1   LDX   SAVEX
E5CD 09              DEX
E5CE BC A004         CPX   ENDA      CHECK FOR END
E5D1 27 F0           BEQ   MEXIT     EXIT IF DONE
E5D3 08              INX
E5D4 A6 00           LDA A 0,X       GET NEXT BYTE
E5D6 08              INX             BUMP FROM-POINTER
E5D7 FF D02C         STX   SAVEX
E5DA FE D042         LDX   NEWLOC
E5DD A7 00           STA A 0,X       SAVE BYTE
E5DF 08              INX             BUMP TO-POINTER
E5E0 FF D042         STX   NEWLOC
E5E3 20 E5           BRA   FWD1      AND REPEAT
              * BACKWARD MOVE
E5E5 B6 A004  BACK   LDA A ENDA      COMPUTE END OF NEW AREA
E5E8 F6 A005         LDA B ENDA+1
E5EB F0 A003         SUB B BEGA+1
E5EE D2 A002         SBC A BEGA      LENGTH OF OLD
E5F1 FB D043         ADD B NEWLOC+1
E5F4 B9 D042         ADC A NEWLOC
E5F7 B7 D042         STA A NEWLOC
E5FA F7 D043         STA B NEWLOC+1  STORE LAST LOC OF NEW
E5FD FE A004         LDX   ENDA
E600 FF D02C         STX   SAVEX     SAVE COPY OF LAST LOC
E603 FE D02C  BACK1  LDX   SAVEX
E606 08              INX
E607 BC A002         CPX   BEGA      CHECK FOR END
E60A 27 B7           BEQ   MEXIT     EXIT IF DONE
E60C 09              DEX
E60D A6 00           LDA A 0,X       GET NEXT BYTE
E60F 09              DEX             BUMP FROM-POINTER
E610 FF D02C         STX   SAVEX
E613 FE D042         LDX   NEWLOC
E616 A7 00           STA A 0,X       SAVE BYTE
E618 09              DEX             BUMP TO-POINTER
E619 FF D042         STX   NEWLOC
E61C 20 E5           BRA   BACK1     AND REPEAT
```

Listing 13. ASCII output routine.

FROMTO to get beginning and ending addresses for the dump. The beginning address is then saved in SAVEX. Next, PRNTOP is called.

PRNTOP uses a method of analyzing the length of an instruction known as the Thompson Lister, named after its originator, Noel Thompson. It begins by printing the address in SAVEX. Then it gets the op code of the instruction and, through a series of comparisons, determines the length of that instruction in bytes. Finally, it prints the operation code plus any following bytes and stores in SAVEX the address of the following instruction.

The rest of DESEMB simply checks to see whether all the data requested has been printed and branches back to print more if not. PRNTOP is an important subroutine because it is also used in single-stepping.

Debugging Functions

HUMBUG's strong point is its debugging facility. Let's look at each of the routines used in debugging commands such as BR (used for setting and resetting breakpoints) and SS (for single-stepping).

When the system was first started, the cold-start routine in E4ROM filled each of the twelve locations of BKTAB with FF. BKTAB is used to store the current four breakpoints as shown in Table 1.

In other words, the first three bytes are used for the first breakpoint, the next three are used for the second breakpoint, and so on.

For each breakpoint, the first two bytes contain the address of that breakpoint, while the third byte holds the operation code of the instruction at that location. A breakpoint is set up by substituting an SWI instruction (3F) for the instruction originally there, so that the program will return to the monitor when it reaches the breakpoint. Since putting in the SWI would erase the first byte of the instruction supposed to be there (the op code), this op code is stored in the BKTAB table so it can be

BKTAB and BKTAB + 1	—Address of breakpoint 1
BKTAB + 2	—Operation code of breakpoint 1
BKTAB + 3 and BKTAB + 4	—Address of breakpoint 2
BKTAB + 5	—Operation code of breakpoint 2

Table 1.

```
                * 'DE' COMMAND - DESEMBLER DUMP

E4B6 BD E009  DESEMB JSR   FROMTO    ASK FOR ADDRESSES
E4B9 FE A002         LDX   BEGA
E4BC FF D02C         STX   SAVEX
E4BF BD E4D1  DES2   JSR   PRNTOP    GO TO PRINT CURRENT LINE
E4C2 B6 A004         LDA A ENDA      SUBTRACT NEXT FROM LAST
E4C5 F6 A005         LDA B ENDA+1
E4C8 F0 D02D         SUB B SAVEX+1
E4CB B2 D02C         SBC A SAVEX
E4CE 24 EF           BCC   DES2      RETURN IF NEXT <= LAST
E4D0 39              RTS             OTHERWISE EXIT

                * PRNTOP - SUBROUTINE TO PRINT ADDRESS AND CURRENT INSTRUCTION

E4D1 BD FC0F  PRNTOP JSR   CRLF
E4D4 CE D02C         LDX   #SAVEX    GET LOCATION OF NEXT ADDRESS
E4D7 BD FC2D         JSR   OUT4HS    PRINT IT
E4DA BD FC30         JSR   OUTS
E4DD FE D02C         LDX   SAVEX     GET ADDRESS OF INSTRUCTION
E4E0 A6 00           LDA A 0,X       GET OPERATION CODE
E4E2 B7 D044         STA A INSTR     SAVE IT
E4E5 BD FC2A         JSR   OUT2HS    PRINT IT
E4E8 FF D02C         STX   SAVEX     INCREMENT SAVEX
E4EB 5F              CLR B           BYTE COUNTER
E4EC B6 D044         LDA A INSTR
E4EF 81 8C           CMP A #$8C      ANALYZE OP CODE FOR NO OF BYTES
E4F1 27 18           BEQ   LENTH3
E4F3 81 8E           CMP A #$8E
E4F5 27 14           BEQ   LENTH3
E4F7 81 CE           CMP A #$CE
E4F9 27 10           BEQ   LENTH3
E4FB 84 F0           AND A #$F0
E4FD 81 20           CMP A #$20
E4FF 27 0B           BEQ   LENTH2
E501 81 60           CMP A #$60
E503 25 08           BCS   LENTH1
E505 84 30           AND A #$30
E507 81 30           CMP A #$30
E509 26 01           BNE   LENTH2
E50B 5C       LENTH3 INC B           3-BYTE:8C,8E,CE,7X,BX,FX
E50C 5C       LENTH2 INC B           2-BYTE:2X,6X,8X,9X,AX,CX,DX,EX
E50D F7 D046  LENTH1 STA B COUNT     1-BYTE:1X,3X,4X,5X
E510 01              NOP
E511 01              NOP
E512 27 10           BEQ   POP3
E514 7A D046         DEC   COUNT
E517 27 05           BEQ   POP1
E519 BD FC2D         JSR   OUT4HS    PRINT 2 BYTES
E51C 20 03           BRA   POP2
E51E BD FC2A  POP1   JSR   OUT2HS    PRINT ONE BYTE
E521 FF D02C  POP2   STX   SAVEX     INCREMENT NEXT
E524 39       POP3   RTS
```

Listing 15. DEsemble routine.

```
                * 'BP' COMMAND - PRINT BREAKPOINT LOCATIONS

E68B C6 30    BPRINT LDA B #'0       BREAKPOINT NUMBER IN ASCII
E68D CE D036         LDX   #BKTAB
E690 FF D02C         STX   SAVEX
E693 5C       BPR1   INC B
E694 C1 35           CMP B #'5       STOP AT 5 BREAKPOINTS
E696 26 01           BNE   BPR2
E698 39              RTS             RETURN WHEN DONE
E699 BD FC0F  BPR2   JSR   CRLF      PRINT CR
E69C 17              TBA             GET BP NUMBER
E69D BD FC0C         JSR   OUTEEE    PRINT BREAKPOINT NUMBER
E6A0 FE D02C         LDX   SAVEX     GET ITS LOCATION IN TABLE
E6A3 A6 00           LDA A 0,X       GET BP ADDRESS
E6A5 81 FF           CMP A #$FF      IS THERE ONE?
E6A7 26 05           BNE   BPR3      YES, GO PRINT IT
E6A9 08              INX
E6AA 08              INX             NO, UPDATE POINTER
E6AB 08              INX
E6AC 20 0C           BRA   BPR4      AND REPEAT
E6AE BD FC30  BPR3   JSR   OUTS      PRINT SPACE
E6B1 FE D02C         LDX   SAVEX
E6B4 BD FC2D         JSR   OUT4HS    PRINT ADDRESS OF BREAKPOINT
E6B7 BD FC2A         JSR   OUT2HS    PRINT OP CODE
E6BA FF D02C  BPR4   STX   SAVEX     SAVE BKTAB LOCATION OF NEXT
E6BD 20 D4           BRA   BPR1      AND REPEAT
```

Listing 16. Print breakpoints routine.

restored later.

When the table is first initialized, it is filled with FFs. Since a breakpoint can never be placed at location FFFF (which is in ROM and contains a vector, rather than an instruction), having an FFFF as the address of each of the breakpoints is an impossible condition used to signify that the breakpoint doesn't exist.

BP Command

The BP monitor command prints out the locations and operation codes of the current breakpoints. For instance, if breakpoint number 2 is at location 1000, the operation code that belongs in that location is 86, and all other breakpoints are unused, then the printout would be as follows:

```
1
2  1000 86
3
4
```

Listing 16 lists the BPRINT subroutine, which prints the breakpoints. It simply scans through BKTAB and prints out the contents for each breakpoint that doesn't have an address of FFFF. The only unusual part of the routine is that the loop counter, which counts up to four breakpoints, is maintained in ASCII. It goes from 31 (the ASCII code for a 1) up to 34 (the ASCII code for a 4) so that it functions both as a counter as well as the number printed at the start of each line.

BR Command

Setting and resetting breakpoints is done with the BR command, which is executed by the BREAK subroutine shown in Listing 17.

For example, if the BR command is used to set up breakpoint number 2 at location 1000,

```
                * 'BR' COMMAND - SET/RESET UP TO FOUR BREAKPOINTS

E61E 8D 45      BREAK  BSR   BKNUM     GET NUMBER OF DESIRED BREAKPOINT
E620 FF D02C           STX   SAVEX     SAVE ADDRESS
E623 8D 22             BSR   BERASE    GO ERASE OLD ONE
E625 CE E582           LDX   #NEWSTR   PRINT "ENTER NEW ADDRESS: "
E628 BD FC12           JSR   PDATA
E62B BD FC1E           JSR   BADDR     GET ADDRESS
E62E FF D042           STX   NEWLOC
E631 E6 00             LDA B 0,X       GET PRESENT OP CODE
E633 86 3F             LDA A #$3F      GET SWI INSTRUCTION
E635 A7 00             STA A 0,X       SUBSTITUTE IT
E637 FE D02C           LDX   SAVEX     GET POINTER TO BRKTAB AGAIN
E63A B6 D042           LDA A NEWLOC
E63D A7 00             STA A 0,X       STORE ADDRESS IN TABLE
E63F B6 D043           LDA A NEWLOC+1
E642 A7 01             STA A 1,X
E644 E7 02             STA B 2,X       STORE DELETED OP CODE
E646 39                RTS             AND RETURN
                * ERASE PREVIOUS BREAKPOINT, IF ANY, AND RESTORE OP CODE
E647 E6 02      BERASE LDA B 2,X       GET OP CODE
E649 A6 00             LDA A 0,X       GET PART OF ADDRESS
E64B 81 FF             CMP A #$FF      WAS THERE A BREAKPOINT?
E64D 27 0B             BEQ   BEEXIT    NO, EXIT
E64F EE 00             LDX   0,X       YES, GET ADDRESS OF BREAK
E651 E7 00             STA B 0,X       RESTORE OP CODE
E653 FE D02C           LDX   SAVEX
E656 86 FF             LDA A #$FF
E658 A7 00             STA A 0,X       ERASE BREAKPOINT TABLE ENTRY
E65A 39         BEEXIT RTS             AND RETURN

                * BKNUM ROUTINE - GET NUMBER OF DESIRED BREAKPOINT AND POINT
                * TO ITS LOCATION IN BKTAB TABLE

E65B 20         BNSTR  FCC   ' NUMBER: '
E664 04                FCB   4
E665 CE E65B    BKNUM  LDX   #BNSTR
E668 BD FC12           JSR   PDATA
E66B BD FC09           JSR   INEEE     GET BREAKPOINT NUMBER
E66E 80 30             SUB A #$30      CONVERT FROM ASCII
E670 2B 16             BMI   NGEXIT    IF NEGATIVE
E672 27 14             BEQ   NGEXIT    IF ZERO
E674 81 04             CMP A #$4
E676 2E 10             BGT   NGEXIT    IF GREATER THAN 4
E678 36                PSH A
E679 BD FC30           JSR   OUTS
E67C 32                PUL A
E67D CE D036           LDX   #BKTAB
E680 4A         BKN1   DEC A
E681 27 07             BEQ   OKEXIT    EXIT WHEN INDEX POINTS CORRECTLY
E683 08                INX
E684 08                INX             BUMP INDEX BY 3
E685 08                INX
E686 20 F8             BRA   BKN1      AND REPEAT
E688 31         NGEXIT INS             FIX STACK TO BYPASS CALLING ROUTINE ON ERROR
E689 31                INS
E68A 39         OKEXIT RTS             RETURN WHEN DONE
```

Listing 17. Breakpoint set/reset routine.

```
                 * BREAKPOINT RE-ENTRY POINT AFTER SWI IN MAIN PROGRAM

E6BF BF A008  BKRETN STS   SP        SAVE USER STACK POINTER
E6C2 30              TSX             TRANSFER TO INDEX
E6C3 8E D07F         LDS   #$D07F    RESET TO MONITOR STACK
E6C6 6D 06           TST   6,X       DECREMENT USER PC TO POINT...
E6C8 26 02           BNE   RONLY     ...TO SWI, NOT PAST IT
E6CA 6A 05           DEC   5,X       DECR LEFT BYTE
E6CC 6A 06    RONLY  DEC   6,X       DECR RIGHT BYTE, AND CONTINUE TO PRINT REG

                 * 'RE' COMMAND - PRINT USER REGISTERS FROM STACK

E6CE BD FC0F  REGIST JSR   CRLF
E6D1 FE A008         LDX   SP        POINT TO USER STACK
E6D4 E6 01           LDA B 1,X       GET CC REGISTER
E6D6 58              ASL B
E6D7 58              ASL B           READY FOR SHIFTING INTO CARRY
E6D8 CE 0006         LDX   #6        SET COUNTER
E6DB 58       RELOOP ASL B           MOVE NEXT BIT INTO CARRY
E6DC 86 30           LDA A #$30
E6DE 89 00           ADC A #0        CONVERT TO ASCII
E6E0 BD FC0C         JSR   OUTEEE    PRINT IT
E6E3 09              DEX             BUMP COUNTER
E6E4 26 F5           BNE   RELOOP    PRINT NEXT BIT
E6E6 BD FC30         JSR   OUTS      PRINT SPACE
E6E9 FE A008         LDX   SP        POINT TO USER STACK AGAIN
E6EC 08              INX             STEP PAST CC REGISTER
E6ED 08              INX             POINT TO B ACCUMULATOR
E6EE BD FC2A         JSR   OUT2HS    PRINT B
E6F1 BD FC2A         JSR   OUT2HS    PRINT A
E6F4 BD FC2D         JSR   OUT4HS    PRINT INDEX
E6F7 BD FC2D         JSR   OUT4HS    PRINT PC
E6FA B6 A008         LDA A SP
E6FD F6 A009         LDA B SP+1      GET CURRENT USER STACK
E700 CB 07           ADD B #7
E702 89 00           ADC A #0        CHANGE BACK TO VALUE IT HAD IN USER PGM
E704 B7 D02C         STA A SAVEX
E707 F7 D02D         STA B SAVEX+1   TEMP SAVE IT
E70A CE D02C         LDX   #SAVEX    POINT TO IT
E70D BD FC2D         JSR   OUT4HS    PRINT IT
E710 7E FC06         JMP   HOTST     AND RETURN TO FCROM
```

Listing 18. Breakpoint reentry and register print routines.

the whole exchange with the monitor would be:

BR NUMBER: 2 ENTER NEW ADDRESS: 1000
(user's entries are underlined).

Only a number from 1 to 4 is allowed for a breakpoint number; any other entry will return to the command loop without doing anything.

As soon as a valid breakpoint number is entered, the old breakpoint (if any) is restored and erased from the table. If the new address is valid, then the new breakpoint is set up; but if the new address is a carriage return or any other invalid character, then no new breakpoint is entered. This is, therefore, a good way of erasing breakpoints.

Listing 17 first goes to the subroutine BKNUM, which asks for the breakpoint number and points the index register at the corresponding entry in the BKTAB table. This pointer is then saved in SAVEX.

Next, subroutine BERASE erases the old breakpoint (if any) from the table. It looks at the first byte of the breakpoint address in the table. If this byte is not FF (no breakpoints can exist at locations FF00 through FFFF, since this is all ROM), then it gets the op code from the table, puts it back into the original address and puts an FF into BKTAB to make the address invalid.

Finally, the program asks for the new address and then pulls a switch. The op code is yanked out of the breakpoint location, a 3F is substituted, and the breakpoint address and the op code are placed into BKTAB.

SWI Reentry

What happens when a user program runs and hits a breakpoint? You may remember from last month's article that FCROM has an address of FFED in the SWI interrupt vector at location FFFA. When an SWI interrupt occurs, the 6800 will look into location FFFA to get the address to go to. In this case, it will start executing a program at FFED.

But there were two instructions starting at FFED that loaded into the index register the number in location A012 and then executed JMP 0,X. Hence, the number in A012 is a pointer to the real starting point of the SWI service routine. This pointer is in RAM so it can be changed by user programs.

A012 is initialized during the initial power-up sequence to point to BKRETN, so an SWI interrupt eventually winds up at BKRETN. This routine is shown in Listing 18.

When an SWI gets us to BKRETN, the contents of the stack pointer are stored at location SP, or location A008. At this point, the stack pointer points to the next empty location of the user stack, just under the seven bytes that hold all the register data that was dumped into the stack by the 6800 when it performed the SWI.

The next instruction following BKRETN transfers the contents of the stack pointer to the index register. However, the 6800 adds 1 to this number before it loads it into the index register. Thus, now the index register points to the last of the seven bytes, instead of the next empty location.

The stack now has the following seven bytes:
Program counter (low)
Program counter (high)
Index register (low)
Index register (high)
A Accumulator
B Accumulator
CC Reg.—IX now points here
Empty—SP now points here

In the next step, the stack pointer is loaded with the address of the monitor stack at D07F, so that all following operations use a different stack area.

The next four instructions subtract one from the PC (program counter) contents stored in the user stack. The PC, as stored after the SWI, points to the next instruction after the SWI itself. Subtracting one points it back to the SWI, so that when the contents of the PC are printed, it will indicate the address where the breakpoint occurred, rather than the address of the next byte. This is essential, so that when we continue from the breakpoint we resume at the instruction which had been replaced by the breakpoint, rather than the next byte after it.

After this is done, the program continues into the same routine that is executed for the RE, or register, dump command.

This REGIST routine uses the contents of SP to point to the user's stack. Its function is similar to SWTBUG's R command, but it does it in a slightly different way. First, it separates the bits of the condition code register and prints them separately, instead of printing them as a hex number, as SWTBUG does. Second, it adds 7 to the stack pointer before printing it. For instance, if SWTBUG printed a register dump as

C4 BB AA 1234 5678 4321

HUMBUG would print it as

000100 BB AA 1234 5678 4328.

Why the difference in the stack pointer? SWTBUG prints the stack pointer the way it exists after the breakpoint SWI instruction; HUMBUG prints it the way it was just before the breakpoint.

Listing 19 shows the steps used for executing the CO command. SWTBUG has a G command that is used both for starting programs as well as for continuing after a breakpoint; HUMBUG has separate GO and CO commands.

GO is used just for starting a program. It always uses the contents of A048 and A049 for a starting address. CO, on the other hand, is used only for continuing after a breakpoint or single-step. It can't be used to start a program, since the contents of SP are undefined at the beginning.

SS—Single-Stepping

Executing the single-step command was shorter and simpler than I expected. The entire single-step routine is shown in Listing 20.

```
                 * 'CO' COMMAND - CONTINUE AFTER A BREAKPOINT

E713 BE A008  CONT   LDS   SP        GET USER STACK POINTER
E716 3B              RTI             AND RETURN TO HIS PROGRAM
```

Listing 19. Continue from breakpoint routine.

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The SS command uses the contents of the SP, or stack pointer, location, which is initialized only upon reentering after a breakpoint, so SS can only be used after breakpoints. This is a minor annoyance at first, but you'll get used to it. (E8ROM actually has an ST, or STart, command to get around this, but that is not necessary for our purposes.)

When the SS command is called, the STEP routine of Listing 20 uses the user stack pointer to get the current user program counter and saves it in USERPC and also in SAVEX. Then it goes to PRNTOP, which uses SAVEX to find the instruction, prints it and then updates SAVEX to point to the next instruction. This pointer is also left in the index register when PRNTOP finishes.

The next part of STEP, starting at location E725, uses this pointer to pull out the op code of this instruction, save it in memory and replace it with a 3F or SWI. It then checks whether this 3F was stored. If not, it goes to NOGOOD to print the error message NO! This prevents single-stepping through ROM or nonexistent memory.

Eventually, the monitor will jump to the instruction to be performed and execute it. Right after this instruction is an SWI, which will return to the monitor immediately after the one instruction being executed. But what if that instruction is a jump or branch, so that the following SWI is never executed? The next part of the monitor, starting at OK1, checks for that.

If the instruction about to be stepped through is a jump or branch, then another SWI is placed at the location where the computer will jump. There are now two SWI instructions, so

Listing 20. Single-step routine.

```
                * 'SS' COMMAND - SINGLE STEP AFTER BREAKPOINT
E717 FE A008  STEP   LDX   SP       GET USER STACK POINTER
E71A EE 06           LDX   6,X      GET USER PC
E71C FF D02E         STX   USERPC   SAVE IT
E71F FF D02C         STX   SAVEX
E722 BD E4D1         JSR   PRNTOP   PRINT ADDRESS AND INSTRUCTION
                * REPLACE NEXT INTRUCTION WITH SWI
E725 FF D030         STX   NEXT     SAVE ADDRESS
E728 A6 00           LDA A 0,X      GET INSTRUCTION
E72A B7 D032         STA A NEXT+2   SAVE IT
E72D 86 3F           LDA A #$3F     GET SWI
E72F A7 00           STA A 0,X
E731 A1 00           CMP A 0,X      CHECK IT
E733 27 02           BEQ   OK1      IT STORED OK
E735 20 35           BRA   NOGOOD   ABORT IF ERROR
                * NEXT, SEE IF A BRANCH OR JUMP IS INVOLVED
E737 B6 D044  OK1    LDA A INSTR    GET OP CODE
E73A 81 20           CMP A #$20
E73C 25 04           BCS   NOBR     NO BRANCH
E73E 81 30           CMP A #$30
E740 25 6E           BCS   YESBR    YES
E742 81 39    NOBR   CMP A #$39     CHECK FOR RTS
E744 26 03           BNE   NOTRTS   NO
E746 7E E7EF         JMP   RTSIN    YES
E749 81 3B    NOTRTS CMP A #$3B
E74B 27 1F           BEQ   NOGOOD   DON'T DO RTI
E74D 81 3F           CMP A #$3F
E74F 27 1B           BEQ   NOGOOD   DITTO FOR SWI
E751 81 6E           CMP A #$6E
E753 26 03           BNE   NOTJIN
E755 7E E7DE  JINV   JMP   JINDEX   OK FOR INDEXED JUMPS
E758 81 AD    NOTJIN CMP A #$AD
E75A 27 F9           BEQ   JINV     DITTO
E75C 81 7E           CMP A #$7E
E75E 27 77           BEQ   JEXT     OK FOR EXTENDED JUMPS
E760 81 BD           CMP A #$BD
E762 27 73           BEQ   JEXT     DITTO
E764 81 8D           CMP A #$8D
E766 27 48           BEQ   YESBR    BSR IS A BRANCH TOO
E768 81 3E           CMP A #$3E
E76A 26 15           BNE   NORMAL   OK IF NOT WAI
                * REFUSE TO DO SOME INSTRUCTIONS
E76C CE E77D  NOGOOD LDX   #NOSTR
E76F BD FC12         JSR   PDATA    PRINT "NO!"
E772 FE D030         LDX   NEXT
E775 B6 D032         LDA A NEXT+2
E778 A7 00           STA A 0,X      RESTORE NEXT INSTR ON ERROR
E77A 7E FC06         JMP   HOTST
E77D 4E       NOSTR  FCC   'NO!'
E780 04              FCB   4
                * NORMAL INSTRUCTIONS ARE EASY
E781 86 FF    NORMAL LDA A #$FF     ERASE ALT ADDRESS LOC
E783 B7 D033         STA A BRANCH
E786 CE E790  GOUSER LDX   #SSRETN  REDIRECT SWI RETURN
E789 FF A012         STX   SWIJMP
E78C BE A008         LDS   SP       GET USER STACK
E78F 3B              RTI            GO TO USER
```

that if a conditional branch is involved, we'll stop whichever way we go. (And, of course, the deleted instruction is saved.) This is somewhat complex for relative branches and indexed JMPs and JSRs, but this is handled by routines that add or subtract offsets.

There are other instructions that need checking. An RTS is executed by fetching the return address from the stack. HUMBUG doesn't attempt to execute the difficult RTI, SWI and WAI instructions.

Once everything is set up, the program advances to GOUSER at location E786, ready to do an RTI to go to the user program. But first we must initialize the RAM location SWIJMP at A012 with the return address of SSRETN (instead of BKRETN) just before we go to the user program. Otherwise, the SWI, which will return to HUMBUG, will return us to the breakpoint routine instead of back to the single-step routine.

After the single-step is performed, the computer returns back to the single-step program at SSRETN. This part of the program now resets SWIJMP to point back to BKRETN, erases the SWI instruction and replaces it with the original byte, erases the alternate SWI, which had been placed into the program for jumps and branches, and then goes to BKRETN to save the stack pointer and print registers as it does after a normal breakpoint.

Conclusion

With this information, you can now construct your own version of HUMBUG. If you prefer to obtain complete source code on disk or cassette, or burned EPROMs, contact Star-Kits, PO Box 209, Mt. Kisco, NY 10549. ■

```
                * RETURN POINT FROM SINGLE STEP
E790 CE E6BF    SSRETN LDX   #BKRETN   RESTORE BREAK ADDRESS
E793 FF A012           STX   SWIJMP
E796 FE D030           LDX   NEXT      RESTORE NEXT OP CODE
E799 B6 D032           LDA A NEXT+2
E79C A7 00             STA A 0,X
E79E B6 D033           LDA A BRANCH    CHECK BRANCH ADDRESS
E7A1 81 FF             CMP A #$FF
E7A3 27 08             BEQ   NONE
E7A5 FE D033           LDX   BRANCH    RESTORE IT
E7A8 B6 D035           LDA A BRANCH+2
E7AB A7 00             STA A 0,X
E7AD 7E E6BF    NONE   JMP   BKRETN    STORE STACK PTR AND PRINT REGISTERS
                *
                *HANDLE EFFECTIVE ADDRESS OF BRANCH
E7B0 FE D02E    YESBR  LDX   USERPC
E7B3 E6 01             LDA B 1,X       GET OFFSET
E7B5 27 06             BEQ   ZEROOF
E7B7 2B 18             BMI   MINOFF
                * PLUS OFFSET
E7B9 08         PLUSOF INX             ADD OFFSET TO INSTR ADDRESS
E7BA 5A                DEC B
E7BB 26 FC             BNE   PLUSOF
E7BD 08         ZEROOF INX             POINT TO NEXT INSTR
E7BE 08                INX
E7BF FF D033    GOTADD STX   BRANCH    SAVE ADDRESS
E7C2 A6 00             LDA A 0,X       GET INSTRUCTION
E7C4 B7 D035           STA A BRANCH+2  SAVE IT
E7C7 86 3F             LDA A #$3F
E7C9 A7 00             STA A 0,X       SUBSTITUTE SWI
E7CB A1 00             CMP A 0,X       CHECK THAT IT WENT IN
E7CD 27 B7             BEQ   GOUSER    GO TO USER IF OK
E7CF 20 9B             BRA   NOGOOD    IF IT DIDN'T STORE PROPERLY
                * MINUS OFFSET
E7D1 09         MINOFF DEX             SUBTRACT OFFSET
E7D2 5C                INC B           FROM INSTR ADDRESS
E7D3 26 FC             BNE   MINOFF
E7D5 20 E6             BRA   ZEROOF
                *
                * HANDLE EXTENDED JUMP ADDRESS
E7D7 FE D02E    JEXT   LDX   USERPC
E7DA EE 01             LDX   1,X       GET EXTENDED JUMP ADDRESS
E7DC 20 E1             BRA   GOTADD    GO TAKE CARE OF IT
                *
                *HANDLE INDEXED JUMP
E7DE FE D02E    JINDEX LDX   USERPC
E7E1 E6 01             LDA B 1,X       GET OFFSET
E7E3 FE A008           LDX   SP
E7E6 EE 04             LDX   4,X       GET USER INDEX REGISTER
E7E8 09                DEX
E7E9 09                DEX             POINT TO 2 BYTES UNDER
E7EA 5D                TST B
E7EB 27 D0             BEQ   ZEROOF    IF OFFSET IS ZERO
E7ED 20 CA             BRA   PLUSOF    IF OFFSET IS NONZERO
                *
                * HANDLE RTS INSTRUCTION
E7EF FE A008    RTSIN  LDX   SP        GET USER STACK POINTER
E7F2 EE 08             LDX   8,X       GET RETURN ADDRESS FROM USER'S STACK
E7F4 20 C9             BRA   GOTADD    AND TREAT IT AS A JUMP
```

TVBUG—A Closer Look

Another view of using this colorful 6800 system.

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Woburn, MA 01801

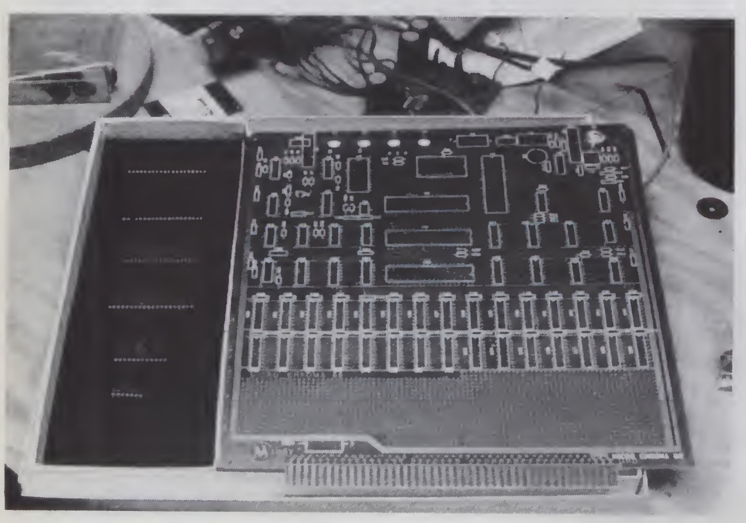
I had wanted for some time to buy a microprocessor, but had held off because I could find no inexpensive computer with full-color graphics and enough on-board memory to run BASIC. Then I read a fascinating *Kilobaud* article on TVBUG (June 1979) that described such a computer with everything I wanted.

After looking without success for the kit locally, I found an advertisement from Austin Electronics in Austin, TX. I purchased the circuit board and the LSI devices (6808 CPU, 6847 graphics chip, 6850 ACIA and so on) and the remainder of the support chips, which included 1K of stack RAM, 1K of graphics memory and 1K of user memory (Photo 1). The price was $269.

I also purchased the full complement of the on-board memory (2114 low-power 300 ns RAM chips), bringing the user memory to 8K and the graphics memory to 6K. The cost of the additional memory was $150.

Once in my workshop, I was impressed that all the integrated circuits were socketed and of prime quality. The chips were on foil-covered conductive foam and the components were sorted in separated packs. Construction time was approximately eight hours. I hooked my keyboard to the processor board via a 20-line ribbon cable with an IC DIP socket (Photo 2).

Photo 1. Bare board and LSI devices as supplied by Motorola.



The keyboard must have a negative-going pulse greater than 100 ms. I took the strobe pulse from my keyboard, which was a positive-going pulse of about ten ms duration, and wired it to a 74121 one-shot monostable monovibrator. I used a potentiometer on the resistor-capacitor network of the 74121 to adjust the pulse length. By using the inverted output (Fig. 1) you have the negative-going pulse required by the processor. The potentiometer should be adjusted for a negative pulse of 100 ms duration.

I attached a regulated 5-volt power supply to the power terminals, ran the rf video line to a 60 decibel switch on my television set, plugged in the keyboard and ran a "smoke test." To my surprise, I saw the header label on the television. I promptly tried all the commands and everything worked as advertised—that is, everything except the cassette tape.

After many hours of debugging, I discovered I had neglected to insert a resistor on the main board. After soldering the resistor in place, everything worked perfectly.

Check the board carefully to be certain that every component has been inserted correctly. When adjusting the potentiometers for the tape drive, place it approximately midway between maximum and minimum resistance. On the tape recorder, I used a volume of 9 and a tone control of 0.

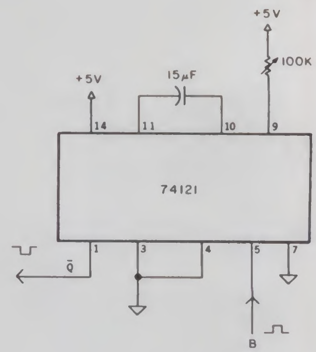


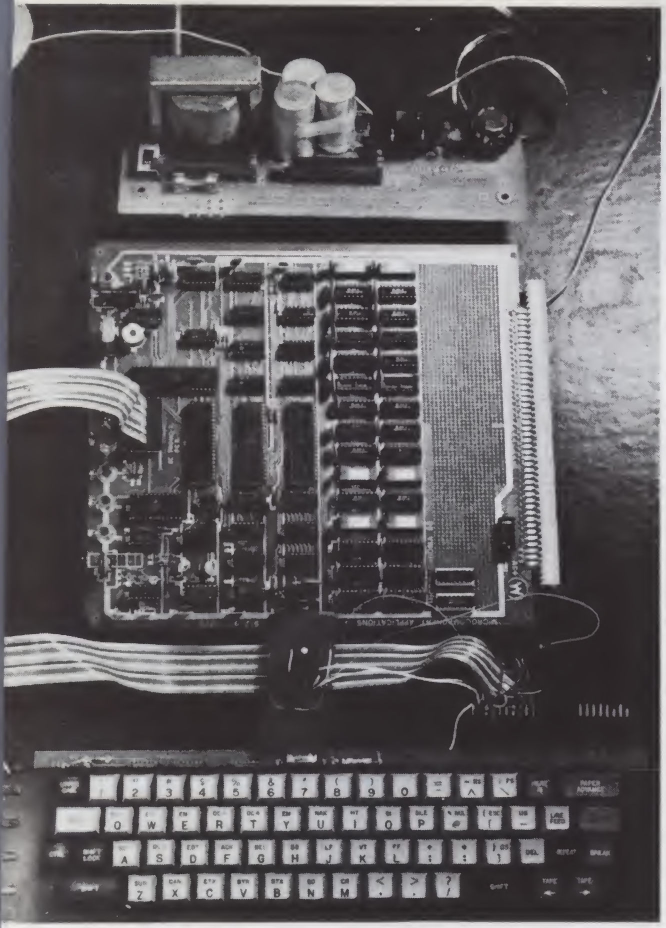
Fig. 1. Schematic for inverting and stretching the keyboard strobe pulse.

Software

The 6800 microprocessor has an abundance of software. The main problem with the existing software is that it has been written for the BUG series (e.g., MIKBUG, SWTBUG). The microprocessors in the BUG series have software monitors to support various configurations of systems.

Motorola's MIKBUG came out with a ROM (read only memory) operating system. From then on, the basic 6800 microprocessor systems have been further modified.

The TVBUG is unique in the BUG series; it uses an on-board video driver. The TVBUG also has moved the monitor to the upper 2K of memory with the stack and I/O just below the monitor in memory. The current memory layout is more logical; it gives a large contiguous segment of memory beginning at lo-



hoto 2. Completed computer with keyboard, 20-line ribbon cable, ulse-stretching circuit and power supply.

ation 0 hex and extending to FFFF.

The manual for the TVBUG ontains the modifications to echnical Systems Consultants oftware. The modifications for ASIC were for the 10K version nd not for the 4K version. I ound that the 4K version, which omes with the listing, could be asily modified to run on the TV-UG. I hope to add graphics to ASIC shortly.

The cassette tape for the TV-UG is reliable. It has one short-oming: Even though it is Kan-as City Standard tape, the for-nat is different from the other UGs. To overcome this prob-em, Motorola has included a andler to read the more com-mon S1–S9 format tapes. The andler, included in the manual, esides at location E800. The oard has memory decoding for his memory, but there is no on-oard memory wired for this lo-ation.

An EPROM or ROM would be the best way to store the han-dler, but I added 1K of 2114 RAM to the board, so the handler must be entered from tape before use. This 1K of RAM has worked out well; I use this mem-ory for special programs, leav-ing the lower memory for the main programs.

Things to Come

The TVBUG has an edge con-nector for the Motorola Exorcis-er series. This is unwired, and no buffering is supplied. I am cur-rently working on an interface to the SS-50 bus. The interface will include full buffering of the sig-nals, and the I/O area on the motherboard will be modified. The modifications to the I/O area will include moving the I/O area to a different part of memo-ry and allowing 16 addresses for each I/O slot, so that devices like the 6522 can be used. Once the TVBUG has a bus, the whole line of SS-50 boards are avail-able for expansion. ■

A BASIC Translation Algorithm

Become multilingual in computer dialects.

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Versions and dialects of BASIC have proliferated like rabbits all over the microcomputing landscape. Articles with programs include statements such as, "This program is written in XYZ BASIC, version Q, but can easily be modified to run on other systems."

I began asking friends more experienced in microcomputing if they had tried such modifications. Some had not. Others gave up because other systems had commands or statements for which their systems had no counterpart. One had heard about *The BASIC Handbook*, but did not think it worthwhile to do the necessary cross-reference work.

When friends were of no help, I searched through old microcomputing magazines, only to find that no one has addressed the problem.

If the problem is so simple that no one is bothered by it, I thought maybe it is too trivial to deserve attention. On the other hand, it may be so big that no one really knows where to grab it. In either case, a foray into the jungle seemed the only way to find some answers.

I encountered a small adversary in the September 1979 issue of *Microcomputing* in a technical article by Allan S. Joffe ("ON X GOSUB VVVV,TTTT," p. 32) illustrating the use of a supposedly little known instruction: ON X GOSUB VVVV,TTTT.... The program was short and clearly written, and did not seem to be a formidable adversary. But after a look at the first line, I seriously considered a retreat:

```
5 CLS
```

My North Star Horizon 2 BASIC does not have anything that remotely resembles the CLS instruction. Since it was the first instruction and did not seem tied closely to other statements, I guessed it might be a clear screen command. A TRS-80 user confirmed this guess. I loaded the remainder of the program as published, with a few obvious changes needed in the formatting symbols. Nothing worked!

Rewriting the little program from scratch would have been fairly easy, but my interest was in developing skills that could be used on bigger games. Therefore, I sought a logical approach to translation.

I worked out a series of steps and tested it on the program mentioned above. A bare bones translation is given in Program 1, and an expanded version is shown in Program 2. By changing appropriate names and multiplication factors, either of these programs can be used to convert a variety of quantities, such as degrees Fahrenheit to centigrade. They might also be used as subroutines, as was done in the original program.

```
10 OUT 2,27\OUT 2,42
20 PRINTTAB(15),"Metric Conversion Operations Number Table" \PRINT
30 PRINTTAB(5),"1 = INCHES TO CM",\PRINTTAB(40),"2 = CM TO INCHES"
40 PRINTTAB(5),"3 = YARDS TO METERS",\PRINTTAB(40),"4 = METERS TO YARDS"
50 PRINTTAB(5),"5 = MILES TO KILOM",\PRINTTAB(40),"6 = KILOM TO MILES"
60 PRINT\PRINT
70 INPUT "Type number of units to be converted  ",C\PRINT
80 INPUT "Enter from above table number of operation you want. ",D\PRINT
90 ON D GOTO 100,110,120,130,140,150,
100 C = C*2.54\GOTO 160
110 C = C*.393\GOTO 160
120 C = C*.9144\GOTO 160
130 C = C*1.0936\GOTO 160
140 C = C*1.609\GOTO 160
150 C = C*.6214\GOTO 160
160 PRINT C
170 FOR J=1 TO 3000\NEXT J
180 GOTO 10
```

Program 1.

Translation Procedure

1. Study a general textbook on BASIC. As fine as some of the tutorial materials supplied with microcomputers are, study of a general text will broaden your understanding of the general conventions in BASIC. A local computer club may make this study easier by providing a class, or the local library may supply the text.

2. Carefully read the published program. It is important to understand what each line of the program contributes. Mark subrou-

tines, if used, for easy recognition.

Many different techniques will be useful in this step. Even though your memory is larger than your computer's, make notes about the program on a separate sheet, especially if it is not well documented. You will want a list of variable names and uses, subroutine locations and some identification for each and a list of statements that do not seem to have equivalents in your system's BASIC.

3. Draw a flowchart if the program is more than 20 lines long. So few flowcharts are published as part of programs that I questioned whether this technique was passé. I asked two professionals, and both emphatically said that flowcharting is a very important tool, even if done only mentally. One said that he requires potential employees to solve a specific problem; those who attempt it without flowcharts take longer, if they solve it at all.

4. Translate small sections of the program that produce clearly defined outputs. These segments may be subroutines, but some subroutines can be broken up to give more manageable chunks of program. The outputs may not ordinarily be visible when the program is run. To be sure they are within the desired ranges, temporarily insert PRINT statements to reveal the transient values. Do not make other program modifications at this stage.

5. Load and run these segments, one at a time.

6. Debug the segments. You then have a chance to learn the meaning of some of the foreign statements and format signs. Your bug may be confined to a small number of lines; swatting it will thus be easier, whether you have a minimal system or one such as the North Star with lots of diagnostic helps.

7. Store the debugged segments for later insertion into the main program.

8. For each segment go to step 4. When you reach this point, process the next segment by beginning at step 4. If there are no more segments to treat, then go to step 9.

9. Insert the segments into the main program, one or two at a time. Further debugging can be done at this time. Many of the print instructions used earlier can be deleted. Use STOP, HALT or END, as appropriate to your system, to give you hints as to where the bugs may be hiding.

10. Debug the program as a whole. Subroutine incompatibilities may show up at this time, although these will rarely be a problem if the original program is well written and you have not inserted modifications beyond those suggested. That is one advantage of using someone else's brainchild.

11. Run the program with normal and unanticipated data inputs. In response to prompts, put in alphabetic information where numeric is expected. Insert blanks instead of data of any kind. Do the same with control characters. Do anything that an idiot user might conceivably do to make the program crash. Make careful notes on inputs that disrupt the program.

As an example, an input of 1.999999999 to signify the operation number in Programs 1 and 2 will be interpreted as 2. This gives the wrong conversion and incomprehensible results. A simple way to avoid this problem has not yet been found, though attempts are still being made. A user unaware of the problem might lose a wad of money basing his purchases on the incorrect answer.

12. After completion of the above steps, and only then, make modifications to fit your needs or whims. The importance of holding modifications to this point cannot be overemphasized. The only exceptions are those suggested for debugging above and insertion of remarks to help you understand and remember the purpose of the program segments.

General Notes

Programs with generous documentation are the easiest to translate. It may be in the form of flowcharts, remarks or text explanation. Documentation is therefore an important factor to consider in deciding which program to translate.

The algorithm given above is longer than that for writing an original program. Steps 3 to 10 are those usually used for original program writing. Step 1 *is not required for each* program, so the extra effort involved is not as great as it may first appear.

Even so, why bother to translate?

First, you can learn how someone else solved the problem posed by the program. Translation is much more effective as a learning aid than a simple reading of the program. This will add new techniques to your problem-solving bag of tricks.

Second, translation is often much less time- and energy-consuming than writing an original program, once the technique described above has been mastered. The more complex the program, the more time you will save.

You will find some BASICs similar to your own. Others are radically different. I was fortunate to be challenged by one that was quite different for a first attempt.

Translation Notes

Here are some of the problems presented

```
10 REM program to perform some English-Metric conversions
20 REM by Eugene Fleming, Sept. 1979, version 1.0
30 REM Based on article in MICROCOMPUTING, Sept. 1979, p. 32
40 DIM J$(1), D(2)\D = INT(D)
50 OUT 2,27\OUT 2,42
60 REM Next 6 lines are title and table prints
70 PRINTTAB(15),"Metric Conversion Operations Number Table" \PRINT
80 PRINTTAB(5),"1 = INCHES TO CM",\PRINTTAB(40),"2 = CM TO INCHES"
90 PRINTTAB(5),"3 = YARDS TO METERS",\PRINTTAB(40),"4 = METERS TO YARDS"
100 PRINTTAB(5),"5 = MILES TO KILOM",\PRINTTAB(40),"6 = KILOM TO MILES"
110 PRINTTAB(5),"7 = GALLONS TO LITERS",\PRINTTAB(40),"8 = LITERS TO GALLONS"
120 PRINTTAB(5),"9 = POUNDS TO KGMS",\PRINTTAB(40),"10 = KGMS TO POUNDS"
130 PRINT\PRINT
140 INPUT "Enter from above table number of operation you want. ",D\PRINT
150 REM Next 4 lines check and prompt for incorrect entry
160 IF D<>INT(D) THEN 180\REMPrevents acceptance on decimal number
170 IF D>=1 AND D<=10 THEN 210
180 PRINT "Carefully select the operation and retype your choice."
190 PRINT "Entry must be a whole number in range 1 to 10."
200 GOTO 140
210 INPUT "Type number of units to be converted  ",C\PRINT
220 LET A = C
230 ON D GOTO 250,260,270,280,290,300,310,320,330,340
240 REM Conversion routines
250 C = C*2.54\GOTO 360
260 C = C*.393\GOTO 360
270 C = C*.9144\GOTO 360
280 C = C*1.0936\GOTO 360
290 C = C*1.609\GOTO 360
300 C = C*.6214\GOTO 360
310 C = C*3.785\GOTO 360
320 C = C*.2642\GOTO 360
330 C = C*.4535\GOTO 360
340 C = C*2.205\GOTO 360
350 REM Print routines for answers
360 IF D=1 THEN PRINT A," inches =",C," centimeters"
370 IF D=2 THEN PRINT A," centimeters =",C," inches"
380 IF D=3 THEN PRINT A," yards =",C," meters"
390 IF D=4 THEN PRINT A," meters =",C," yards"
400 IF D=5 THEN PRINT A," miles =",C," kilometers"
410 IF D=6 THEN PRINT A," kilometers =",C," miles"
420 IF D=7 THEN PRINT A," gallons =",C," liters"
430 IF D=8 THEN PRINT A," liters =",C," gallons"
440 IF D=9 THEN PRINT A," pounds =",C," kilograms"
450 IF D=10 THEN PRINT A," kilograms =",C," pounds"
460 PRINT "Do you wish to do another conversion?  Type YES or NO."
470 INPUT "Then press RETURN  ",J$
480 IF J$ = "Y" THEN 50
490 PRINT "The computer is now leaving the METRIC CONVERSION program."
500 END
```

Program 2.

by the translation of the conversion program and techniques used to solve them. North Star BASIC has no direct equivalent for several of the TRS-80 instructions. A call to the local dealer gave me information on how to clear the screen under program control. He did not know quite how it works, but it does the job, so it is now recorded in my manual. It is used in Program 1 at line 10 and in Program 2 at line 50.

All print and input statements were modified, but my familiarity with my system language made this easy.

No direct equivalent of the ON X GOSUB VVVV,TTTT statement, which is the subject of Joffe's article, is available in North Star BASIC, so some program restructuring was required. However, I dug into the manual and discovered a similar one. It is ON X GOTO VVV,TTT. RETURN in his program had to be replaced with GOTO YYY to make the program operate as intended. Since this procedure was new to me, another tool has been added to my collection.

I had to move the PRINT C statement from above the computation subroutines to follow them to be effective.

The pause statement, FOR J=1 TO 1500\NEXT J, did not hold the results on screen long enough to be read, so I increased the count to 3000. Since this was my first encounter with a statement designed to generate a pause, it took a lot of head scratching to figure out its purpose. Chalk up one more tool.

Finally, I moved the loop formed by the statement in line 70 GOTO 5 to the very end, since the C* constants were not subroutines that could be left outside the loop in the revision.

I have purposely not used some features of the North Star BASIC in this translation to make it more easily understood.

Practical Exercise

Enough intellectualizing for now. To test your comprehension of this article's suggested techniques, translate either of the programs listed here into your system's BASIC. I would be interested to know how it works for you.

Some Questions

If this system works so well for translating dialects of BASIC, will it work for converting BASIC to Pascal or FORTRAN IV? Logically, it should, but there are vast differences in language structures. BASIC and CHIP 8 are the only languages I know. CHIP 8 is far too different for a direct translation, and on a minimal system I could find no way to reasonably implement this program. However, a flowchart for a game such as Wumpus would be identical. ■

DEALER DIRECTORY

COMPUTER CLINIC

I am interested in corresponding with computerists who have had experience in converting or using the Magnavox Odyssey 2 beyond its video game capability. If enough interest is generated, I will start a newsletter and/or users group.

Everett Rantanen
2829 S. 56th Ct.
Milwaukee, WI 53219

My school has recently purchased a TRS-80 Level II 16K computer, which we are rapidly expanding into a full-blown computing system with disk I/O and line printers. I have been asked to check into the possibility of an accessory or a completely different system that would distinguish between the different types of lunch tickets. Has anyone heard of such a device?

Patrick Eastman
Rt. 25
Kezar Falls, ME 04047

There are whispers around that someone is about to hit the market with a cassette recorder for under $250 that has eight-track parallel input. I assume this means that it is much like a tape reader, only much faster. Best of all, it will offer approximately eight times the storage capacity per tape as a standard cassette recorder.

It seems to me that the electronics for parallel I/O are simpler than serial I/O, and therefore cheaper to build. But who makes an inexpensive eight-track head? Any information regarding the existence of such a cassette recorder would be appreciated.

S. B. Wahlberg
PO Box 502
Silverado, CA 92676

I need a beginner's-level explanation of the software aspects of the Percom LFD-400 disk operations and how to modify existing programs to use disk storage. The LFD-400 systems manual assumes that the reader knows more about the general concept of disk operations than, at least, I do.

I have written to Percom, but all I received in reply were several programs, which I was advised to study. I suppose that this is a possible, but time-consuming, way of learning. Does anyone have a good beginner's tutorial on how to write software for the Percom LFD-400 disk system?

Buren R. Shields
900 Idlewilde Ln., SE
Albuquerque, NM 87108

CALENDAR

Interface West '80

The fourth annual Interface West Conference and Exposition is set for Oct. 28–30 at the Los Angeles Convention Center. Conference sessions will cover small computer systems, word processing systems, facsimile transceivers, interconnect phone systems, software packages, micrographics equipment, media and supplies.

For more information call toll-free 800-225-4620 (in Massachusetts, call 617-879-4502).

Music Conference

The International Computer Music Conference is set for Nov. 13–16 in Flushing, NY. Activities planned include concerts, workshops, panel discussions, meetings of special interest groups, demonstrations and a special exhibition of computer music equipment.

For information contact Dr. Hubert S. Howe, Jr., Queens College, Flushing, NY 11367.

Ham/Computer Flea Market

Bergen Amateur Radio Association is having a ham and computer swap and sell on Saturday, Oct. 11, at the Bergen Community College on Paramus Rd. in Paramus, NJ. Tailgating only; bring your own tables. Send SASE for flyer. Sellers, $3; buyers, free. Contact Vic WB2PYE—201-664-6833/0155 or Jim KB2EI—201-445-2855, evenings, or write to Vic Jurkovic, 325 Wilson Ave., Westwood, NJ 07675.

New Jersey Computer Show

The 1980 New Jersey Personal Computer Show and Fleamarket (NJPCS) will be the first home and hobby computer show ever held in Northern New Jersey. The show is Sept. 27 and 28 at the Holiday Inn (North), at Newark International Airport (NJ Turnpike Exit 14). Featured will be an indoor commercial exhibit area, a large outdoor fleamarket and user group meetings/forums on the TRS-80, PET, Apple, Heath and other popular systems. For additional information, write: NJPCS, Kengore Corp., 9 James Ave., Kendall Park, NJ 08824.

AEDS Workshops

The Association for Educational Data Systems is offering a series of workshops especially designed for administrators, educators and computer professionals interested in computers in education.

Workshops offered include: Programming with PASCAL—Learning When and Why, Sept. 25–26 in St. Louis, MO; Computerized Data Base Management, Oct. 9–10 in St. Louis, MO; Computers as Effective Tools for Education—The Evidence, Oct. 23–24 in Des Moines, IA; Word Processing, Nov. 7 in Wichita, KS; Design and Development of Computer-Based Instructional Materials, Nov. 12–13 in Orlando, FL; and 1981 Micro-Mini Computers, Personal Computers and the Development and Evaluation of Educational Programs in Computer Science and Data Processing, Feb. 12–13 in Orlando, FL, and Mar. 12–13 in St. Louis, MO.

For information, call: 202-833-4100.

Microprocessor Troubleshooting Course

Integrated Computer Systems of Santa Monica, CA, is offering a course on the troubleshooting of microprocessor-based systems. Participants will use a variety of troubleshooting equipment in the class to test and debug hardware and software. The courses are in Anaheim, CA, Sept. 23–26; Washington, D.C., Sept. 30–Oct. 3; Boston, MA, Oct. 14–17; Houston, TX, Oct. 28–31; and Saddle Brook, NJ, Nov. 18–21.

For information write Integrated Computer Systems, 3304 Pico Blvd., PO Box 5339, Santa Monica, CA 90405, or call 800-421-8166.

Personal and Business Computer Shows

Business and Home Computer Shows are planned in Washington, D.C., Chicago and Boston this fall. The shows will include the Home of Computerized Comfort, a computer-retrofitted residence and office designed to demonstrate the latest in computerized energy-saving systems and state-of-the-art electronic conveniences.

The Mid-Atlantic Business and Home Computer Show will take place in Washington, D.C., Sept. 18–21.

The Mid-West Business and Home Computer Show will be held in Chicago, Oct. 16–19.

The Northeast Business and Home Computer Show is scheduled in Boston, Nov. 20–23.

For more information contact: Computer Expositions, Inc., PO Box 678, Brookline, MA 02147, 617-524-0000.

Computer Crime Conference

A major international conference called "Computer Crime Info—Computer Security and Fraud Control" is set for Dec. 1–3 in Arlington, VA. The conference will examine the primary management issues and available solutions for government and business executives in addressing computer security issues and combating computer crime.

The sponsor is The Information Exchange, a non-profit organization dedicated to innovative programs for dissemination of information to the business and managerial communities.

For further information contact Gil Merritt at 703-521-6209.

ACM Annual Conference

"Previewing the Computer Age" is the theme of the ACM Annual Conference in Nashville, TN, Oct. 27–29. The Conference will include state-of-the-art technical papers, an expanded exhibit of computing and data communications equipment, the 11th ACM North American Computer Chess Championship, a variety of student activities, and special events which feature or will honor the pioneers in the computing profession.

For information contact Charles Bradshaw, Box 1980 Station B, Nashville, TN 37235, 615-322-2951.

Personal Computer Fair

The Northwest Computer Society and the Pacific Science Center will sponsor the third annual Personal Computer Fair in Seattle, WA, Nov. 8–9. The theme will be "Hands On." For more information, write the Northwest Computer Society, PO Box 4193, Seattle, WA 98119.

Western Educational Computing Conference

The theme of the WEC Conference, Nov. 20–21, is "Educational Computing in the '80s" and will feature papers and seminars on the use of computing in higher education for instruction, administration and research. Luncheon speakers will be Capt. Grace Hopper, USN, and Bernard Luscombe, President, Coastline College. For information contact Ron Langley, Director, Computer Center, California State University, Long Beach, 1250 Bellflower Boulevard, Long Beach, CA 90840, or call 213-498-5459.

Edited by Dennis Brisson

MICRO-SCOPE

Commodore's Starring Role on TV . . .

Personal computers have finally achieved the "status" of food processors, car wax and trips to Acapulco. Commodore International has been promoting its computers on a variety of television game shows; in many cases the game shows requested Commodore computers. One show, "Quiz Kids," tried giving away a different brand of computer before the young contestants who won wrote back and asked for a more sophisticated computer. Commodore obliged.

Other shows presenting PETs or CBMs as prizes include "Hollywood Squares," "Price is Right," "Name That Tune," "Tic Tac Dough" and "The Joker's Wild."

Robert Cascarino, general manager of Commodore's mid-Atlantic region, with "Quiz Kids" finalists David Luongo and Irene Herlighy, both 13, and game-show host Jim McKrell. David and Irene both won Commodore PET computers for winning the finalist play-off on "Super Quiz Kids." Both had won more than five consecutive shows as contestants. Irene lives in Cambridge, MA, and David lives in Malden, MA.

. . .and on the Screen

Commodore has announced that it will sponsor a documentary film entitled "Breakthrough," a look at new ways in which handicapped people can communicate. One of the segments in the film will feature use of a computer to communicate by severely handicapped individuals.

"Breakthrough" will be released January 1, in conjunction with the United Nations' 1981 "Year of the Disabled" campaign. The film will also be shown on public television in the U.S. and other countries. Producers of the film are Lauron Productions Ltd. in Toronto. Sponsorship of this film is in conjunction with Commodore's "computer awareness" program, which is designed to disseminate information about what computers can do today for groups who might not otherwise be aware of them.

Commodore International Limited donated six of its CBM/PET computer systems to the United Nations International School at a ceremony held at the school in New York City. Irving Gould, chairman of the board of Commodore, presented the systems to Mrs. Murray Fuhrman, special representative of the Secretary-General for the United Nations International School, Robert Belle-Isle, director of the school and Dr. Thomas Szell, head of the science department. Mrs. Fuhrman noted, "The Commodore PET is the school's strong preference because of its outstanding graphics with full mixed text, its speed, compactness of design and particularly because of its wide acceptability and utilization by educational institutions worldwide."

Scoring the Perfect 10

At the recent U.S. Olympic gymnastic trials, Altos computers scored impressively high marks for executing the statistical and scoring functions. Programming Consultants International, the official computer scoring company for the U.S. Gymnastic Federation and the Women's Gymnastic Association, selected the Altos, which has "virtually eliminated the need for gymnastic statisticians." The meet was telecast by NBC, whose viewers were treated to simultaneous statistical and scoring computations performed by Altos and NBC's Chyron computer-based character generator.

The multiuser capabilities of the Altos system permitted the concurrent operation of five terminals during the Olympic trials. NBC utilized three Altos-polled terminals. Color announcers Kurt Thomas and Nancy Theis and the mobile production van worked with two for statistical information, while their Chyron unit employed the third. The judges worked with the other two terminals to input the official scoring data. The Altos team will next travel to Montreal to score the October World Cup of Gymnastics and then onto Mexico City for the twenty-first World Gymnastic Championships.

Wanted: Systems Analysts

You don't need a calculator to figure out that the pay for computer systems analysts is good. And, according to the July issue of *Money* magazine, the job prospects for analysts in the 1980s are strong, with growth projected at 37 percent and a "substantial shortage" of computer specialists forecast by mid-decade.

The average starting salary of $17,000 climbs to about $28,000 in five years, and salaries are highest in New York, Chicago and Los Angeles. The big organizations that use computers the most tend to pay the most, but small firms may pay a bonus for a top

talent, according to the magazine article. For the most part, analysts are a contented group. "Their one serious complaint is that they have no well-traveled career path to the higher levels of the company. The best they can do, usually, is chief of computer operations," says *Money*.

Many successful analysts don't hold college degrees, but learned computer programming inside a corporation or at a technical school. The recommended educational route these days, however, is to get a B.S. in business or even an M.B.A., both of which include computer science in their curricula.

As society becomes more computer-dependent, more systems analysts will be needed. Essentially, systems analysts must know what computers can do, rather than be able to work directly on the machines. Also, like all problem solvers, they must be able to communicate well, to determine their client's needs and express the realistic abilities of what computers can do. As for the immediate job outlook, there will be less hiring during the recession, but over the decade, more jobs will be available than analysts to fill them.

Small Computer Probes Stress and Heart Disease

Research that could lead to prevention of stress-induced heart attacks is being carried out at the University of Pittsburgh's Western Psychiatric Institute with the aid of a small Digital Equipment Corporation MINC laboratory computer. The DEC computer controls and analyzes experiments, as researchers expose volunteers to testing that places them under psychological stress to determine which influences in a stressful daily routine could adversely affect the human heart.

Volunteers listen to tones of slightly different pitches and must press an appropriate button within a specific time interval. The order of tones is random, under computer control, and the tones are made difficult to hear by including noise in the earphones. Test results are evaluated to determine alterations in measurements such as rate of heart action and breathing.

The MINC computer system, a modular system designed for laboratory applications, is the major analytical element for the experimental program. It incorporates special plug-in interfacing modules that enable a researcher to customize the system for specific experimental applications. In addition to controlling the experiments, the MINC does major analyses, both in BASIC and FORTRAN. For some statistical work, the researchers send the gathered data to a DEC system-10 mainframe computer located elsewhere in the university.

Man vs Machine

Computers experienced the agony of defeat at the first U. S. Othello tournament held recently at Northwestern University in Evanston, IL. World Othello champion Hiroshi Inoue and U. S. Othello champion Jonathan Cerf, son of the late Bennet Cerf, author and publisher, managed to hold their ground in the contest against six computer entries.

Inoue defended his title against Cerf and the six computer programs. He lost only one match to an IBM 370, programmed by a team from England. In addition to losing his match against Inoue, Cerf succumbed to only one computer game—programmed by Dan and Kathe Spracklen of San Diego, CA—by a 14-piece difference. The Spracklen's entry proved to be the best computer program in the contest. They have previously attained computer game notoriety with their championship microcomputer chess program, Sargon II.

New Releases for the TRS-80*

—Utilities—

We're proud to present three disassemblers for the TRS-80. For speed and simplicity, we recommend The Disassembler. For complex disassemblies, especially if you wish to make alterations, you may prefer one of our Labeling Disassemblers, either TLDIS or DLDIS.

TLDIS & DLDIS

You've bought a super machine-code program, but now wonder how it works. Maybe you even used a quick PEEK routine to glance through it when it was in memory. If so, you definitely noticed the complete lack of comments in the code, making it almost impossible for you to decipher and understand it.

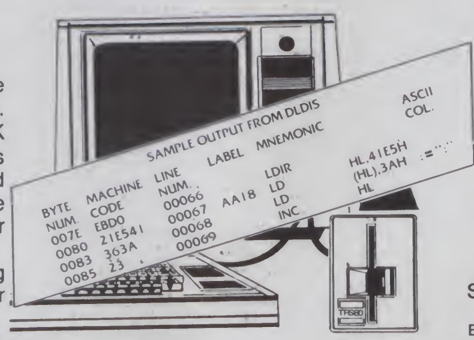
Well, Instant Software's Labeling Disassemblers are the answer to your problem.

TLDIS (Tape-based Labeling DISassembler) and DLDIS (Disk-based Labeling DISassembler) are three-pass, label-assigning disassemblers which assign labels (where appropriate) to the routines in a machine-language program. Their output is almost identical to that of a hand-assembled source code.

You can send the disassembly to a lineprinter (Radio Shack parallel port) for either TLDIS or DLDIS. (The difference between these utilities is the storage mode of the disassembly.)

TLDIS can send the disassembly to cassette tape, DLDIS can send it to disk; both send it to the video monitor. The stored disassembly from TLDIS may be reassembled with Radio Shack's EDTASM(TM)—the disassembly from DLDIS, with Apparat's extension of EDTASM(TM).

Because of the use of labels, it is a simple matter to change any object code program by disassembling it and then making changes to the resultant source code, without losing track of jump/load addresses. Labels start with "AA00" and increment up, in even numbered steps (AA02, AA04, etc.). The odd numbers (AA01, AA03, etc.) are left for you to use for the source code during reassembly.



The printing of the disassembly may be temporarily halted by using [SHIFT] @ (just as in BASIC) or it may be ended by pressing the [BREAK] key. It also has a comments column to display ASCII charachters used in a LD or CP opcode.

Because TLDIS and DLDIS work only on in-memory programs, they may be relocated in memory to avoid conflict with the program you disassemble.

The next time you need to "climb inside" a machine-code program, take DLDIS or TLDIS with you. We promise that it will be an easier journey.

Order No. 0230R (TLDIS) $14.95
Order No. 0231RD (DLDIS) $19.95

The Disassembler

This is a single-pass, hex-notation disassembler that will send its output either to tape or to a lineprinter (Radio Shack parallel port). The tape output is directly compatible with Tandy's EDTASM(TM). Thus, you can take an object code tape, disassemble and output it to tape, then use EDTASM(TM) to add, delete, change and even re-assemble your new version.

In addition, it displays the *displacement* and *absolute* address of any relative jumps made by the disassembled program. It also displays any ASCII characters used in a LD or CP opcode.

Sample output from the Disassembler

BYTE NUM.	MACHINE CODE	LINE NUM.	MNEMONIC	COMMENTS COLUMN	
706E	22057B	00053	LD	(7B05H),HL	
7071	183B	00054	JR	$+3DH	;70AEH
7073	FE52	00055	CP	52H	;="R"
7075	2007	00056	JR	NZ,$+09H	;707EH
7077	CD8F70	00057	CALL	708FH	

H means the number is HEX
$ means current location counter.

Since the Disassembler works only on in-memory programs, it has been made relocatable so that you may move it around in memory to avoid conflict with the program you wish to disassemble. As an added option, you may also jump to memory locations and transfer control between Disassembler and other utility programs in your computer.

The Disassembler, use it to examine and analyze *any* machine-code program!

Order No. 0232R $9.95

Enhanced BASIC

Enhance the power of your TRS-80 Level II microcomputer with the Enhanced BASIC package. This package gives you many functions found in Disk BASIC plus other new features, without having to add a disk drive system.

You can have:

1. Enhanced string handling capabilities.
   A. An INSTR search function for finding strings within strings.
   B. Edit strings by replacement of portions of strings with substrings.
   C. Input a whole line of characters into a string variable with your own prompts.
2. Build your own functions.
   A. Use this routine as a shorthand for repeated, complex relationships.
   B. Use your own function names.
3. Use hexadecimal and octal constants directly.
   A. Avoid the hassle of hex-to-decimal manipulations.
   B. Use numeric and strings forms.
4. A decimal-to-hexadecimal conversion function.
   A. Use it directly in program or calculator mode.
   B. Convert from variables or constants.
5. Use up to ten user defined machine-language subroutines.
   A. Define the entry points with a new statement.
   B. POKE in machine-language subroutines with this easy to use feature.
   C. Use this to create faster graphics routines.
6. Simulate keyboard INPUT from the cassette recorder. This powerful feature will allow you to run a "keyboard" session from tape.
   A. Record programs, commands, and input responses on tape.
   B. The programs can RUN and operate exactly as if you were at the keyboard.
7. A keyboard debounce routine cures a stuttering keyboard.
8. All of Enhanced BASIC takes less than 1K bytes.

The package documentation includes detailed instructions, with listings of sample programs, that will have you practicing and using Enhanced BASIC in no time at all.

So stretch the limits of both your imagination and your TRS-80 with the Enhanced BASIC package.

Order No. 0077R (cassette version) $24.95

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Instant Software™

PETERBOROUGH, N.H. 03458
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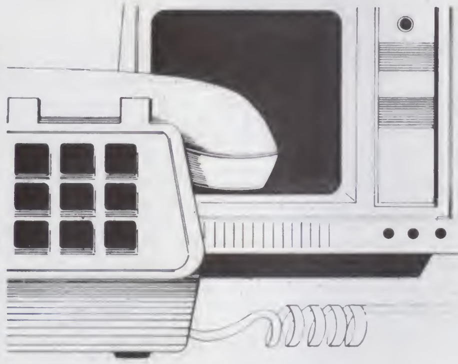
New Releases for the TRS-80*

Telecommunication Software

Terminal-80



The Terminal-80 package lets your TRS-80 communicate with the rest of the world. These programs give you control of the RS-232 port of your Expansion Interface.

You can connect one or more serial terminals to your TRS-80. Your computer will accept input from the RS-232 port just as if it were entered from the keyboard. Thus, you can use your computer from a remote terminal without having to move your equipment.

The TRS-80 can also be transformed into a "dumb" terminal. You can use it in a time-sharing situation to talk to "big" computers via a modem. All data that you type in will go out through the RS-232 port and all incoming data will be displayed on the screen.

You can transfer programs over the phone lines. Just load a program into the TRS-80. The LPRINT/LLIST command will transfer the program to a receiving computer via the RS-232 port.

Using the upper/lowercase modification of the TRS-80 is simplified. (You must have the modification kit installed first or follow the detailed instructions included in this package.) Control characters in Level II and Disk BASIC will be properly displayed and all functions such as CHR$ will work correctly.

This package even includes a BASIC program to set the baud rate. You won't have to tear apart your Expansion Interface if you use more than one configuration.

There are thousands of TRS-80 computers in the world. Let's get together and talk to each other—with the Terminal-80 package from Instant Software.

Order No. 0130R (cassette-based) $24.95

These complementary packages require the following minimum system:

1. A TRS-80 Level II with 16K RAM.
2. An Expansion Interface.
3. An RS-232 Serial Interface (e.g., Radio Shack's No. 26-1145 or the equivalent).
4. An optional upper/lowercase modification kit (for package 130R only).
5. A modem (for package 0126R only).

The Communicator

This program offers you a fast way to transfer data from one location to another, using the telephone lines. The full "ORIGINATE/ANSWER" capability allows your TRS-80 to be controlled from a remote-based terminal, or allows two TRS-80 computers to "talk" to each other.

You will be able to transmit all kinds of data, or programs, from home base to a remote terminal, or between computers, at the speed of light—or at 9600 baud, anyway.

Operation is simple. You dial the telephone number for the desired location. After the connection has been established, each telephone is handset is placed upon its modem and the hook-up is completed. You'll be able to control the home-based TRS-80 from the remote terminal, and can proceed with the transmission of data. This procedure can also be reversed, allowing the home-based TRS-80 to control the remote terminal.

There will be a simultaneous display of information on both of the video monitors, which will facilitate any requests for specific information to be transmitted.

This program would be invaluable to physicians, schools, stockbrokers, police and many others.

Order No. 0126R $9.95

Business

Sales Analysis

If your business is sales, whether as a salesperson or salesmanager, you're faced with some unique problems. How do you keep track of your day-to-day work, in what areas can you improve your sales technique, and how can you determine who your best prospects are? The Sales Analysis package is the answer to all these problems and more.

This package is divided into several modules:

The **Sales Analysis** module is designed to provide guidelines for determining an individual's sales performance, to analyze this performance and show you where it can be improved.

The **Data Storage** module allows you to store data in an automated processing ledger. This will keep names, addresses, phone numbers, appointment dates, etc., in one convenient location, ready for easy reference. The ledger will also show you where each sales prospect is in terms of completing a sale. (A data storage tape is included in the package.)

You won't have to use the shotgun approach when it comes to improving your salesgroup's technique. A **Management Analysis** module can take all the sales records for your group and show you who your best salespersons are, who needs more training and in what areas. It will also give you a sales forecast based on the projected improvement of your group's sales techniques.

Finally, the **Market Analysis** module, combined with the marketing data you supply, can show you where determined sales efforts can produce the most success.

Business software must save you time, money and effort, or it's totally useless. If your speciality is sales, then we have a useful package for you.

Order No. 0131R (cassette-based) $24.95.

TO ORDER: Look for these programs at the dealer nearest you (see list of dealers on page 205). If your store doesn't stock Instant Software send your order with payment to: Instant Software, Order Dept., Peterborough, N.H. 03458 (Add $1.00 for handling) or call toll-free 1-800-258-5473 (VISA, MC and AE accepted).

Instant Software™

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New Releases for the TRS-80*

Mail/List from Galactic Software Ltd.

A Mailing List for the TRS-80 Model I or Model II

Instant Software always tries to provide you with the best software on the market. Although the Mail/File mailing list program is not published by us, it is so good that we want you to try it.

We have two versions of this mailing list. Pkg. 5000RD is for the Model I with the 5-inch disk drive and Pkg. 5001RD is for the Model II with the 8-inch disk drive. The programs are essentially identical except for the storage media and their respective capacities.

With the 5-inch drive, you can store up to 600 names per disk without DOS, or 300 names per disk with DOS. With the 8-inch drive, you can store up to 2500 names per disk, with or without DOS. (If your list is larger than the single disk maximum, it can be distributed over several disks.)

The program maintains separate alphabetical and ZIP code files under constant sort. When you add a name to your list it will be inserted into its correct position in the files. You will never have to sort your list, it will always be ready to print labels.

The program will record your data in nine fields: two for NAME, and one each for ADDRESS, CITY, STATE, ZIP CODE, PHONE NUMBER, PHONE EXTENSION, and a five character CODE field. When you print labels, you have a choice of three different label formats: a three line label, a four line label or a user-defined label. In the three line and user-defined label formats, you may include a message line on your label.

The best feature of this program is the sort process that lets you determine which labels will be printed. You may specify either alphabetical or ZIP code order for all or any part of your list. For example, you can print labels for everyone on your list whose name begins with the letter A, or for all of those people who have the same ZIP code. You can even print labels for only those people named Jones, who are living in a given city or state. (Note: The Model II version can search for *both* first and last names, e.g., John Jones.) Furthermore, you can choose to print labels by using any single field (i.e., specific cities, states, phone numbers, etc.). You may assign specific codes to any name in the CODE field. For example, ACT could stand for active accounts, and INACT for inactive accounts. If you wanted to send a letter to all of your inactive accounts, you would specify the CODE INACT, and labels would be printed only for your inactive accounts. When you print labels, you may specify up to nine different CODES at one time. If your data matches any one of the CODES, a label will be printed.

Files created with the Model I version of this program can be transferred to the Model II version, when you upgrade your hardware.

Package 5000RD requires the following minimum system:
1. A TRS-80 Model I Level II with 16K RAM.
2. An Expansion Interface with 16K RAM (or more).
3. One (or more) mini-disk drives.
4. A compatible printer (80 or 132 columns).
5. TRSDOS version 2.3.

Order No. 5000RD (Model I version) $99.00

Package 5001RD requires the following minimum system:
1. A TRS-80 Model II with 64K of RAM.
2. Additional Expansion Unit drives (optional).
3. Model II TRSDOS version 1.2.
4. A compatible printer (80 or 132 column).

Order No. 5001RD (Model II version) $199.00.

Basic Math Program from EMSI

Although we do not publish this package, it is so outstanding that we would be remiss if we didn't offer it to you, our customers. The Basic Math Program is a comprehensive math teaching package divided into six sections. It is, also, the best educational software that we have seen for teaching arithmetic skills. The package was designed and created by a certified math teacher with 15 years of programming experience.

The first three programs in the package comprise: Whole Number Arithmetic by Teaching Objective. This set includes lessons in Addition, Subtraction and Multiplication. (Whole Number Division by Teaching Objective will be available soon.) The fourth program is Fractions and Mixed Number Arithmetic. Logic and Deductive Reasoning is the fifth program in the set. The Metric-English Conversion program rounds out the series.

You, the teacher, can choose a variety of options from the MENU, so as to custom-tailor both practice and test sessions. The program options include: Number of problems/session, Level of problem difficulty, Number of seconds per problem, Type of assistance to be offered (digit by digit or retry), Type of reward, as well as options specific to the Addition and the Subtraction sections.

This package includes an excellent, 60 page Teacher's Manual that explains how to use all program features—even for those people who have no prior experience with a computer system. The manual introduces and explains all of the teaching objectives in terms of the specific skills to be mastered. It contains detailed instructions on how to use the computer. (It even explains the proper cassette loading procedure in easily understood terms.) The manual goes on to show you *exactly* what material will appear on the computer screen, and how to select the program options. It explains how to use the Analysis of Session Results feature, which shows not only the number of problems/number correct, but displays the actual problems given, notes if an incorrect digit was entered, whether it was corrected during the session and whether the student used the HELP feature.

The Fractions and Mixed Number Arithmetic program shows the student every step of how to solve these problems. It waits for the student to enter each answer and—if he/she has made an error—provides a review of the process, so that the error can be found. It can also be run as a "fraction/mixed number calculator".

The Deductive Reasoning program is a modified and much improved Mastermind-type exercise. It may be played as a game, or used to exemplify the rigorous nature of valid inference.

The Metric/English Conversion program will convert quantities (length, area, volume and weight) from Metric to English, or English to Metric. It includes all of the most commonly used units of measure.

First there was the revolution of Computer Assisted Instruction. Now, there's the evolution of this extraordinary "teacher's aide".

Order No. 5002R $80.00

TO ORDER: Look for these programs at the dealer nearest you (see list of dealers on page 205). If your store doesn't stock Instant Software send your order with payment to: Instant Software, Order Dept., Peterborough, N.H. 03458 (Add $1.00 for handling) or call toll-free 1-800-258-5473 (VISA, MC and AE accepted).

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Computerland of W. LA
6840 La Cienega Blvd., Inglewood
Coast Electronics
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Computerland
24001 via Fabricante No 904,
Mission Viejo
Computer Mart of California
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1378 So. Bascom Ave., San Jose
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Garcia & Associates
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Midwest Micro Computers, Inc.
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Data Domain
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Mark Gordon Computers
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Zim Computers
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W. Vernon Foster Inc.
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Software Shack
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Nebraska
Computerland of Omaha
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Midwest Computer Co. Inc.
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Midwest Computer Co. Inc.
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Portsmouth Computer Center
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Computer Encounter
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501 Rte. 27, Iselin
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Pennsville Shopping Ctr., Pennsville
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Lashen Electronics Inc.
21 Broadway, Denville
Personal Computing Inc.
51 Central Sq., Linwood
Radio Shack/J&J Electronic
Rt. 57 Allen Rd., Hackettstown
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South West Computer Center
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6429 Busch Blvd., Columbus
Computerland
1288 Som Rd., Mayfield Heights
Computer Store of Toledo
18 Hillwyck Dr., Toledo
Forbees Microsystems Inc.
35 N. Broad, Fairborn
Microcomputer Center
7900 Paragon Rd., Dayton
Micro-Mini Computer World
74 Robinwood, Columbus
21st Century Shop
16 Convention Way, Cincinnati
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Radio Shack Dealer
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302 Wyoming Ave., Kingston
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1100 8th Ave. So., Nashville
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671 S. Menden Hall Rd., Memphis
H & H Electronics Inc.
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2142 N. Collins, Arlington
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7620 Dashwood, Houston
K.A. Elect.
9090 Stemmons Frwy., Dallas
Pan American Elect. Inc.
1117 Conway, Mission
Radio Shack Dealer
21969 Katy Freeway, Katy
The Compute Shop
6353 Camp Bowie Blvd., Ft. Worth
Waghalter Books Inc.
3 Greenway Plaza E., Houston

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DC Computer Co.
1911 West 70 South, Provo
Quality Technology
470 E. 2nd So., Salt Lake City

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Rte. 6, Box 65A, Harrisonburg
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2927 Virginia Beach Blvd.
Virginia Beach
Southside Radio Comm.
135 Pickwick Ave., Colonial Heights

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American Mercantile Co. Inc.
2418 1st Ave. S., Seattle
Byte Shop of Bellevue
14701 N.E. 20th St., Bellevue
Computer Connection Inc.
3100 NW Bucklin Hill Rd., Silverdale
Computerland of South King Co.
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Ye Old Computer Shop
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West Virginia
The Computer Corner Inc.
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Municipal Parking Bldg., Charleston

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690 S. Whitney Way, Madison
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3015 W. Wisconsin Ave., Appleton
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3313 University Ave., Madison
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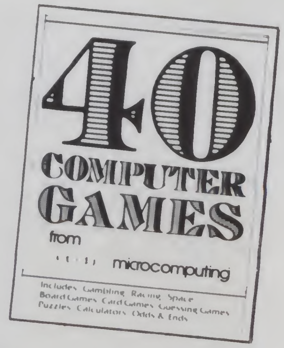

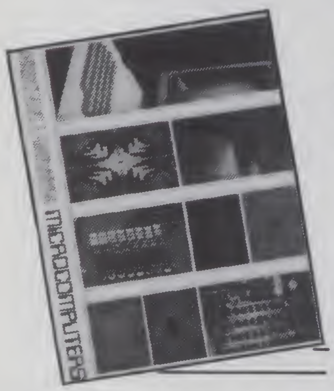

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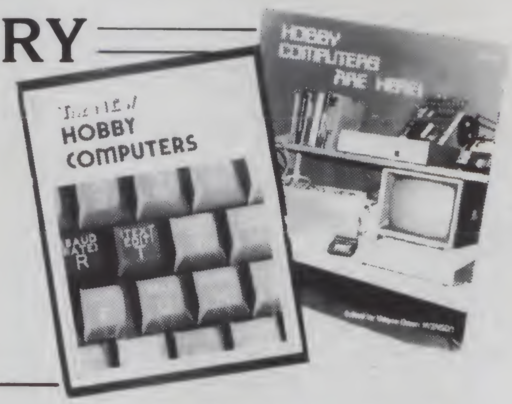

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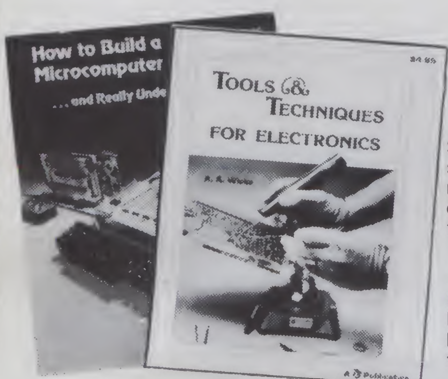

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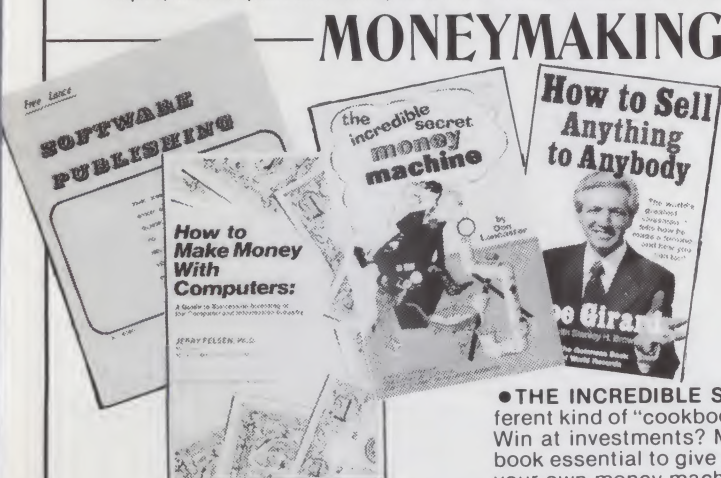

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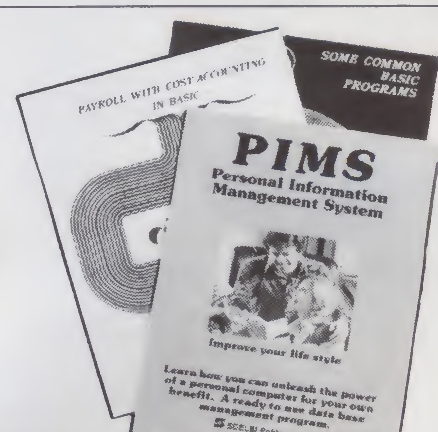

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—Z80—

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—8080 / 8080A—

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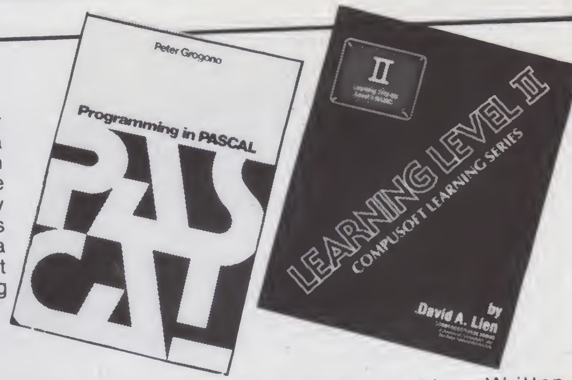
BASIC AND PASCAL



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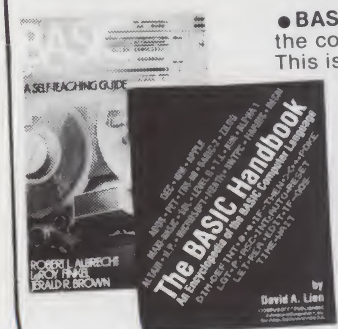

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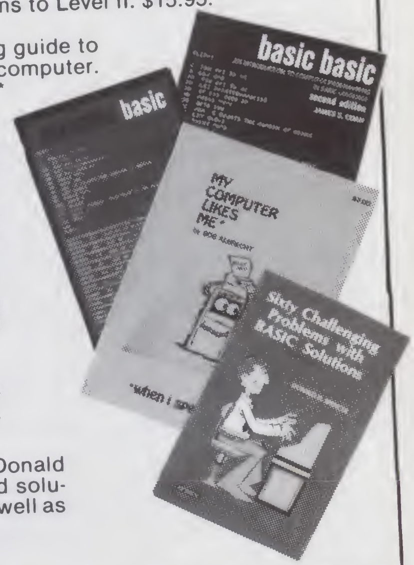

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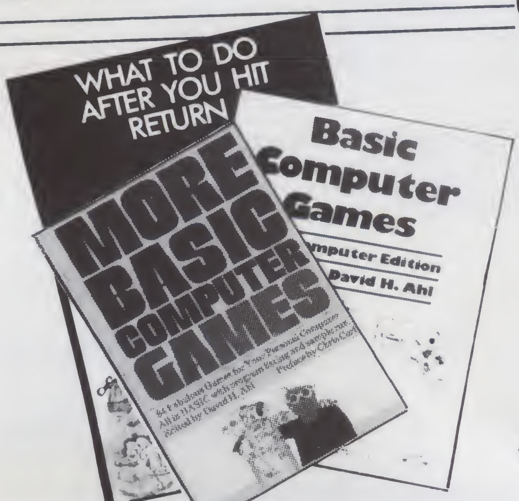
GAMES



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CORRECTIONS

In the article "Open up the 6800," which appeared in the July 1980 issue of *Microcomputing*, there is an error in the section describing the modifications to the motherboard to be used for opening up the $9000–$9FFF range. The modifications described will allow for correct address decoding, but will not modify the data bus buffers properly.

The MP-B motherboard has a set of bidirectional data bus buffers that get their enable signals from IC6, as does IC3. By enabling IC3 with address line A12, the I/O data buffers will still respond to $9000–$9FFF, causing interference with any memory placed at that location.

The fix is a simple one. In Fig. 4 of the article, one gate of IC4 is used as an inverter to drive the chip select (pin 5) of IC3. This inverter (pins 12, 13 and 14) is no longer needed, and pin 5 of IC3 is to be reconnected to ground. Instead, simply connect pin 8 of IC4 directly to pin 6 of IC6, which is an active-high chip-select pin. This will still allow correct address decoding and now will prevent the I/O data buffers from being enabled for addresses $9000–$9FFF.

—Gordon Wolfe—

Several readers contacted *Microcomputing* to inform us that "Predict Variable Trends" (July 1980, p. 140) contains a slight error. Statement 65, which reads

```
65 IF J=I THEN 100
```

should read

```
65 IF J=1 THEN 100
```

The "JazZ-80" article of the May 1980 issue of *Microcomputing* contains an error on p. 149, paragraph 2. The capacitor C2 is not an extra item in the kit. It should be installed in the two holes located below U6 on the circuit board. The problem is that the part number was not stamped on the circuit board.

There are some coding errors in "SORTIT," pp. 120–124, *Microcomputing*, July 1980, which must be corrected if the program is to work correctly. Insert these lines:

```
771 GET(1,E,A$,4)
772 FOR I=1 TO Z
773 C$=A$(I,I)
774 CONVERT C$ TO N(I)
775 NEXT I

2071 B3=B2
```

Change these lines:

```
1530 from FOR Z0=0 TO 3 to FOR Z0=0 TO 4
1640 from FOR B=4 TO I2 to FOR B=5 TO I2
2100 from B4=B3+3 to B4=B3+4
```

—Forest E. Myers—

CLUB NOTES

Hobbyworld Computer Club Alliance
What: Offers discounts to clubs on components, accessories, systems.
Info: Hobby World Electronics, c/o Pat Olson, 19511 Business Center Drive, Northridge, CA 91324.

Z-Users Group
What: Information exchange pertaining to the Pascal/Z compiler and Z-80 and Z8000 software. Distribution of public domain programs on disks using CP/M.
Info: Z-Users Group, 7962 Center Parkway, Sacramento, CA 95823. Charlie Foster, director.

The Apple Cart
What: Special-interest group within American Mensa. Publishes newsletter and operates a software exchange.
Dues: $4 for Mensa members; $6 for others.
Info: SASE to C. Brandon Gresham, Jr., national coordinator, The Apple Cart, 23 Van Buren St., Dayton, OH 45402.

Southern Colorado Computer Club
What: A newly formed club.
When: First and third Tuesdays of each month.
Where: Computer Shack, Pueblo, CO.
Info: Computer Shack, 1635 S. Prairie, Pueblo, CO, 303-564-3545.

80-Users of Houston
What: New meeting place.
When: First Wednesday of each month.
Info: Ben Taylor, 3723 Purdue, Houston, TX 77005, 713-664-5823.

Chicago Area Computer Hobbyist Exchange (CACHE)
What: *CACHE Register* newsletter investigating the roles and uses of hobby micros.
Dues: $10 annually; $5 for grade/high-schoolers.
Info: CACHE, Box 52, South Holland, IL 60473.

Apple for the Teacher
What: Users group emphasizing the educational uses of the Apple computer. Newsletter reviews educational software.
Info: Apple for the Teacher, Ted Perry, 5848 Riddio St., Citrus Heights, CA 95610.

Nashville TRS-80 Computer Club
What: New TRS-80 computer club that operates TRS-80 Model II-based computer bulletin board service.
When: First and third Tuesdays of each month.
Where: ACS Building, 1100 8th Ave., Nashville, TN.
Info: David E. Powell, secretary/treasurer, Nashville TRS-80 Computer Club, 321 Tamworth Dr., Nashville, TN 37214.

Apple SLICE (Salt Lake Intermountain Computer Enthusiasts)
When: Third Wednesday of each month.
Where: Computerland of Salt Lake City.
Info: Gary L. Allen, president, PO Box 536, Bountiful, UT 84010.

North Star Business Club
When: Third Wednesday of each month.
Where: Highline Community College, Seattle, WA.
Info: Dan Baker, secretary, North Star Business Club, PO Box 2516, Lynnwood, WA 98036.

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For Sale: Texas Instruments TI-59 programmable calculator and PC-100 printer, with 4 modules, 80 cards, PPX bulletins, all documentation. $525 value for $395. (201) 663-2402.

For Sale: One Gimix computer nearly new, excellent condition. 6800 CPU card, 16K static memory card (Gimix). $800. Paul Lamar, 123 S. Juanita St., Redondo Beach, CA 90277. Work (213) 374-1673, home (213) 316-8351.

For Sale: Smoke Signal Broadcasting disk controller card, with the following software: on 8" floppy disk, text editing system, disk file BASIC and mnemonic assembler. $250. Paul Lamar, 123 S. Juanita St., Redondo Beach, CA 90277. Work (213) 374-1673, home (213) 316-8351.

Compucolor II for sale: Model 5 (32K RAM), 117 key keyboard, second disk drive, soundware audio, game paddles, programming manual, maintenance manual. Software includes text editor, assembler & much more totaling more than $500. Everything in excellent condition. $2600. Pete Pacione, 2952 N. Meade, Chicago, IL 60634; (312) 889-2674.

Trade ham station for AIM 65. Also trading O.S.I. programs, etc. Write to Henry A. Etchason, Box 147, Sage, AR 72573.

Wanted: Heath H17 floppy-disk system. Not necessarily operable. S. L. Halsted, 303 E. Fernhill Ln., Oak Ridge, TN 37830. (615) 482-5003.

For Sale: Unused Polymorphic System 8813 with 32K RAM memory with floppy-disk drives, printer interface and Abern-Sopher Multiwriter III. System has Canadian import tax paid. Offers for complete system to: Bishop Management, #8—825 McBride Blvd., New Westminster, B.C., Canada, V3L 5B5. 604-525-8148.

For Sale: Heath H8 computer, 24K RAM, H8-2 and H8-5 interface boards, software, H9 video terminal. Current Heath catalog #849 price is $1400+. Asking $750, plus shipping. (414) 321-8387.

Disk programs for sale. 80-90% off original price. Original disks only. One of each. First come first served. Sold my TRS-80. Large SASE for list. Ervin, Box 506, Hialeah, FL 33011.

Intel SBC 80/20 single board computer with I/O (8255s, 8251), 8259 interrupt controller, 8253 interval timer, 8218 multibus controller, 8K ROM, RAM, etc. SBC-116 16K RAM with 8255(2) and 8251 for 6 parallel and one serial port, 8K ROM, timer. SBC-016 16K RAM. SBC-201 dual board disk controller. Cardcage and power supply incl., $1500. Jeff Kenders, 306 Newman Dr., So. San Francisco, CA 94080. (415) 873-1325.

Elf II or other 1802 users, I have some extra 16K static memory boards the same size as and compatible with Netronics 4K boards. Expandable in 4K blocks. On-board 5 V regulators. A complete board will cost about $275. I'm selling only the bare board for $35. No C.O.D.s please. John Ware, 2257 Sixth Avenue, Fort Worth, TX 76110.

For Sale: Optimal Technology EP-2A-7918 EPROM Programmer with personality modules for TMS2708/2716/2532; 2708, 2716, 2732. New & unused in original factory carton. Documentation for Z-80, 8080 interface included, $255. Texas Instruments TI-59, perfect, $165. Call Barnett, (215) 493-8473.

For Sale: Thinker Toys 8080A CPU/FP based system. Includes system monitor, hardware trap, etc. SD 4K LP RAM, SSM VB-1, & Godbout active terminator card. 12-slot mother board, 1st class power supply with line filter, forced air cooling. All mounted in an attractive, sky-blue, rf tight enclosure. Many extras. Perfect condition, $825. Call Barnett (215) 493-8473.

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For Sale: Printer-terminal GTE Novar 5560, IBM 72 Selectric, tape drive. R. Ackerman, 2 Hillside St., Red Bank, NJ 07701. (201) 291-0680 or 741-0923.

For Sale: (2) Hazeltine 1500 video terminals, $825 apiece. Dust covers included with both, maintenance manual available. Both terminals 1 year old. Will ship UPS for certified check. T. Stowe, (201) 295-9105 or J. Boniakowski, (201) 922-3460. P.O. Box 1126, Neptune, NJ.

For Sale: One Wameco EPM-2, 2708/2716 EPROM S-100 card. Assembled but never used. $40 or best offer. Dan Snyder, (717) 272-2001. Ext. 527 day or (412) 287-1625 eve.

For Sale: 2400 BPS synchronous modems; Tele-Signal 883P, equivalent to Bell 201 with many options. SASE for data sheet. Single unit, $135 (3), double, $200. Dolan, Box 23191, Lexington, KY 40503.

Bought Scripsit, selling Pencil, disk version on cassette. Original, not copy—cassette & documentation + my handwritten set of the "undocumented instructions." $150 value for $120. Send money order to Paul Wiener, PO Box 346, Dublin, NH 03444.

For Sale: SD Systems Z-80 Starter Kit, assembled and tested with programming manuals, used once. $200. Greg Overby, 4902 Sonata Dr., Colorado Springs, CO 80918. (303) 598-8820.

Add-on memory for Apple, TRS-80, etc. From scrapped computer board, unused, tested, $50 per 8 4116 16K RAMs. Doug Gennetten, 4425 Goshawk Dr., Ft. Collins, CO 80526. (303) 226-1395.

SYM-1 single-board computer in box with all manuals. 4K RAM. $175. Doug Gennetten, 4425 Goshawk Dr., Ft. Collins, CO 80526. (303) 226-1395. COD ok.

For Sale: TI Silent 700 Printer and H9 Video Terminal. Both excellent condition with documentation. Best offer. R. A. Ackerman, 2 Hillside St., Red Bank, NJ 07701. (201) 291-0680 or 741-0923.

H89 Heath computer, H17 floppy disk, H14 printer. 48K RAM with 204K bytes storage. Microsoft BASIC. Perfect condition. Worth over $4200. Will sell for $3500 or best offer. Call Rudy Straub, 3020 Cranehill Drive, Lynchburg, VA 24503; (804) 528-2867 or (804) 384-6816.

Sale: TRS-80 Exatron stringy floppy with lots of good software on Digital cassettes. Starter pkg. cost $300, will sell for $250. Write: H. Berry, 933 "D" Street, Lincoln, NE 68502 (402) 435-5717.

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7430N 20
7442N 58
7445N 74
7447N 58
7448N 77
7450N 20
7474N 35
7475N 49
7485N 88
7489N 1 85
7490N 43
7492N 43
7493N 43
7495N 69
74100N 1 20
74107N 35
74121N 34
74123N 59
74125N 45
74145N 77
74150N 1 20
74151N 69
74154N 2 00
74157N 69
74161N 87
74162N 1 25
74163N 87
74174N 96
74175N 95
74190N 1 15
74192N 87
74193N 85
74221N 2 75
74298N 1 65
74365N 89
74366N 89
74367N 89

74LS00 TTL
74LS00N 35
74LS02N 35
74LS04N 55
74LS05N 40
74LS08N 45
74LS10N 45
74LS13N 55
74LS14N 1 25
74LS20N 45
74LS22N 45
74LS28N 45
74LS30N 45
74LS33N 75
74LS38N 75
74LS74N 1 25
74LS75N 1 00
74LS90N 1 00
74LS93N 1 00
74LS95N 1 10
74LS107N 65
74LS112N 65
74LS113N 45
74LS132N 89
74LS136N 65
74LS151N 1 10
74LS155N 1 10
74LS157N 1 10
74LS162N 1 65
74LS163N 1 65
74LS174N 2 00
74LS190N 1 25
74LS221N 2 50
74LS258N 1 60
74LS367N 1 65

LINEAR
CA3045 90
CA3046 1 10
CA3081 1 80
CA3082 1 90
CA3089 2 95
LM301AN AH 35
LM305H 87
LM307N 35
LM308N 1 00
LM309K 1 50
LM311H N 90
LM317T K 3 75
LM318 1 35
LM320K-5 1 50
LM323K-5 5 95
LM320K-12 1 50
LM320K-15 1 50
LM320T-5 1 35
LM320T-8 1 35
LM320T-12 1 35
LM320T-15 1 35
LM324N 1 40
LM339N 1 00
LM340K-5 1 35
LM340K 8 1 35
LM340K 12 1 35
LM340K-15 1 35
LM340K 24 1 35
LM340T-5 1 25
LM340T-8 1 25
LM340T-12 1 25
LM340T-15 1 25
LM340T-18 1 25
LM340T-24 1 25
LM350 7 50
LM377 3 50
LM379 5 00
LM380N 1 00
LM381 1 60
LM382 1 60
LM703H 65
LM709H 28
LM723H N 50
LM733N 85
LM741CH 35
LM741N 38
LM747H N 75
LM748N 35
LM1303N 1 75
LM1304 1 10
LM1305 1 27
LM1307 2 00
LM1310 2 75
LM1458 47
LM1812 7 50
LM1889 3 00
LM2111 1 75
LM2902 2 25
LM3900N 60
LM3905 1 75
LM3909N 95
MC1458V 50
NE550N 1 00
NE555V 39
NE556A 85
NE565A 1 00
NE566V 1 50
NE567V 1 00
NE570B 4 75
78L05 60
78L08 60
78M05 85
75108 1 75
75491CN 50
75492CN 55
75494CN 89

A to D CONVERTER
80388 4 50
8700CJ 13 95
8701CN 22 00
8750CJ 13 95
LD130 9 95
9400CJV F 7 40
ICL7103 9 50
ICL7107 14 25

CMOS
CD4000 25
CD4001 35
CD4002 35
CD4006 1 10
CD4007 35
CD4008 28
CD4009 45
CD4010 45
CD4011 35
CD4012 28
CD4013 47
CD4014 1 25
CD4015 1 00
CD4016 55
CD4017 1 05
CD4018 94
CD4019 45
CD4020 1 02
CD4021 1 35
CD4022 1 10
CD4023 28
CD4024 75
CD4025 28
CD4026 2 50
CD4027 66
CD4028 85
CD4029 1 35
CD4030 45
CD4035 1 35
CD4040 1 35
CD4042 85
CD4043 85
CD4044 85
CD4046 1 67
CD4049 45
CD4050 49
CD4051 1 13
CD4060 1 42
CD4066 71
CD4068 40
CD4069 40
CD4070 50
CD4071 45
CD4072 45
CD4073 45
CD4075 45
CD4076 1 65
CD4078 40
CD4081 35
CD4082 35
CD4116 47
CD4490 5 50
CD4507 1 00
CD4508 4 25
CD4510 1 02
CD4511 94
CD4515 2 52
CD4516 1 10
CD4518 1 02
CD4520 1 02
CD4527 1 51
CD4528 79
CD4553 3 50
CD4566 2 25
CD4583 2 35
CD4585 1 10
CD40192 3 00
74C00 35
74C04 40
74C10 35
74C14 1 95
74C20 35
74C30 35
74C48 2 25
74C74 85
74C76 1 75
74C90 1 75
74C93 1 75
74C154 3 00
74C160 2 00
74C175 1 35
74C192 2 25
74C221 2 50
74C905 6 00
74C906 75
74C914 1 95
74C922 6 00
74C923 6 00
74C925 7 50
74C926 6 95
74C927 6 95

INTERFACE
8095 65
8096 65
8097 65
8098 65
8T09 1 25
8T10 4 50
8T13 3 00
8T20 5 50
8T23 3 10
8T24 3 50
8T25 3 20
8T26 1 69
8T28 2 75
8T97 1 69
8T98 1 69

MOS/MEMORY RAM
2101 1 2 95
2102-1 95
2102AL-4 1 34
2102AN 2L 1 60
2104A-4 4 95
2107B-4 3 75
2111-1 3 75
2112-2 3 95
2114L 300ns 6 75
2114L 450ns 5 95
4116 200ns 7 95
8 4116 200ns 49 00
25138 6 30
MM5262 40
MM5280 3 00
MM5320 9 95
MM5330 5 94
PD411D-3 4 00
PD411D-4 5 00
P5101L 8 95
4200A 9 95
82S25 2 90
91L02A 1 50
HD0165-5 6 95
MM57100 4 50
GIAY38500-1 9 95
MCM66751A 9 95
9368 3 50
410D 10 00
416 16 00

CLOCKS
MM5311 5 50
MM5312 3 90
MM5314 3 90
MM5369 2 10
MM5841 14 45
MM5865 7 95
CT7010 8 95
CT7015 8 95
MM5375AA N 3 90
MM5375AG N 4 90
7205 16 50
7207 7 50
7208 15 95
7209 4 95
DS0026CN 3 75
DS0056CN 3 75
MM53104 2 50

MICROPROCESSOR
6502 10 95
6504 9 95
6522 9 95
6800 6 95
6802 11 95
6820 4 95
6850 5 95
8080A 5 95
8085 12 95
8086 75 00
Z80 9 95
Z80A 11 95
8212 2 90
8214 3 95
8216 2 90
8224 3 45
8228 4 95
8251 6 95
8253 15 00
8255 5 75
8257 10 95
8259 14 95
1802CP plas 13 95
1802DP plas 17 95
1861P 11 50
CDP1802CD 28 95
CDP1802D 35 00
CDP1861 15 95

UART/FIFO
AY5-1013 5 50
AY5-1014 7 50
3341 6 95

PROM
1702A 4 95
2513B upper case 8 75
2708 7 75
2716T1 18 00
2716 Intel 23 00
8 2716 Intel 160 00
2732 65 00
2758 22 50
8741A 60 00
8748 65 00
8748-8 60 00
8755A 55 00
N82S23 2 95
N82S123 6 50
N82S126 3 75
N82S129 8 50
N82S131 8 50
N82S136 8 75
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30 pin edge 2 50
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100 pin edge WW 5 25

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Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	14	24	35
16	16	28	42
18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	32	24	86
16	33	28	1 00
18	57	40	1 23

CRYSTALS
1 MHz 4 50
2 MHz 4 50
4 MHz 4 25
5 MHz 4 25
10 MHz 4 25
18 MHz 3 90
20 MHz 3 90
32 MHz 3 90
32768 Hz 4 00
1 8432 MHz 4 50
3 5795 MHz 1 20
2 0100 MHz 1 95
2 097152 MHz 4 50
2 4576 MHz 4 50
3 2768 MHz 4 50
5 0688 MHz 4 50
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MAN3	CC	125	39
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DL707 DL707R	CA	300	1 00
DL727 728	CA/CC	500	1 90
DL747 750	CA/CC	600	1 95
DL750	CC	600	1 95
FND359	CC	357	70
FND500/507	CC/CA	500	1 35
FND503/510	CC/CA	500	90
FND800/807	CC/CA	800	2 20
3 digit Bubble			60
4 digit Bubble			80
DG8 Fluorescent			1 75
DG10 Fluorescent			1 75
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9 50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
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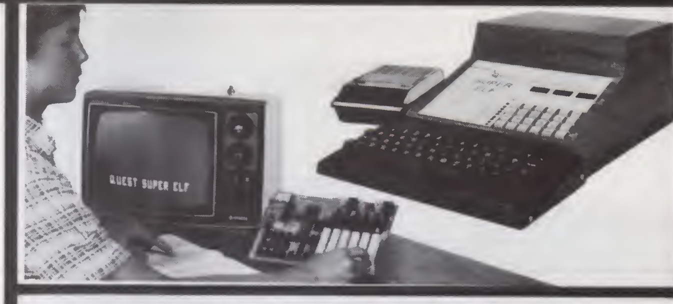

RCA Cosmac 1802 Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

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Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** All metal Expansion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50.** A **50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Announcing Quest Super Basic— *SECOND GENERATION*

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ± 2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O; save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

Enhancements include increased speed, built-in provisions for Stringy Floppy, Floppy Disc, Printer Driver, I/O, user definable command library and statement renumbering.

Easily adaptable to most 1802 systems. Requires 16K RAM minimum for Basic and user programs. Source ***listing for both Serial and*** **Parallel I/O included.**

Super Basic on Cassette $40.00.

PROM Eraser

assembled. 25 PROM capacity **$37.50** (with timer **$69.50**). 6 PROM capacity OSHA/UL version **$69.50** (with timer **$94.50**).

Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50.** Full Kit **$99.00.** Monitor **$20.00.** Power Supply Kit **$35.00. Tiny Basic $30.00**

S-100 Computer Boards

8K Static Godbout Econo IIA Kit	145.00
16K Static Godbout Econo XIV Kit	285.00
24K Static Godbout Econo VIIA-24 Kit	435.00
32K Static Godbout Econo X-32 Kit	575.00
16K Dynamic RAM Kit	199.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
Video Interface Kit	$135.00

80 IC Update Master Manual $55.00

Comp. IC data selector, 2700 pg. master reference guide. Over 51,000 cross references. Free update service through 1980. Domestic postage $3.50.

Modem Kit $60.00

State of the art, orig., answer. No tuning necessary. 103 compatible 300 baud. Inexpensive acoustic coupler plans included.

LRC 7000 + Printer $389.00

40/20 column dot matrix impact, std. paper. Interface all personal computers.

64/40/32/20 version **$405.00.** Optional cables *available.*

LRC 7000 printer interface cable for Super Elf with software **$26.00**

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display. ROM monitor, fully expandable. **$375.00.** 4K version **$450.00.** 4K Assembler **$85.00.** 8K Basic Interpreter **$100.00.**

Special small power supply for AIM65 assem. in frame **$54.00.** Complete AIM65 in thin briefcase with power supply **$499.00.** Molded plastic enclosure to fit both AIM65 and power supply **$47.50.** Special Package Price: 4K AIM, 8K Basic, power supply, cabinet **$599.00**

AIM65/KIM/VIM/Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95.**

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

Video Modulator Kit $8.95

Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/full instruc.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12v option. ±5v, ±12v are regulated. Basic Kit **$29.95.** Kit with chassis and all hardware **$43.95.** Add $4.00 shipping. Kit of hardware **$14.00.** Woodgrain case **$10.00.** $1.50 shipping.

Gremlin Color Video Kit $69.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit **$4.95**

1802 16K Dynamic RAM Kit $149.00

Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$63.00**

Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95**

Tiny Basic Extended on Cassette **$15.00**
(added commands include Stringy, Array, Cassette I/O etc.)
S-100 4-Slot Expansion **$ 9.95**
Super Monitor VI.I Source Listing **$15.00**

Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

Super Color S-100 Video Kit $129.95

Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Editor Assembler **$25.00**
(Requires minimum of 4K for E/A plus user source)
1802 Tiny Basic Source listing **$19.00**
Super Monitor V2.0/2.1 Source Listing **$20.00**

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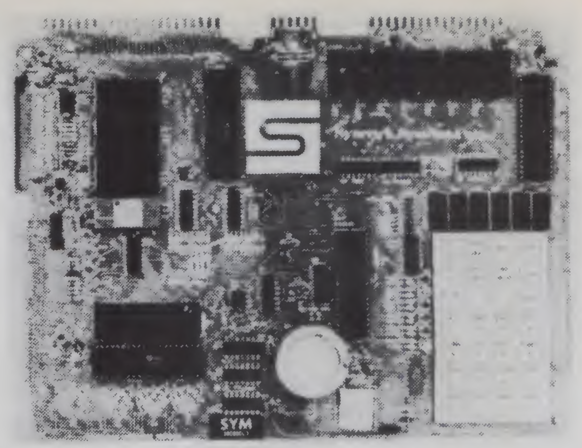
SYM-1, 6502-BASED MICROCOMPUTER

- FULLY-ASSEMBLED AND COMPLETELY INTEGRATED SYSTEM that's ready-to-use
- ALL LSI IC'S ARE IN SOCKETS
- 28 DOUBLE-FUNCTION KEYPAD INCLUDING UP TO 24 "SPECIAL" FUNCTIONS
- EASY-TO-VIEW 6-DIGIT HEX LED DISPLAY
- KIM-1* HARDWARE COMPATIBILITY
  The powerful 6502 8-Bit MICROPROCESSOR whose advanced architectural features have made it one of the largest selling "micros" on the market today.
- THREE ON-BOARD PROGRAMMABLE INTERVAL TIMERS available to the user, expandable to five on-board.
- 4K BYTE ROM RESIDENT MONITOR and Operating Programs.
- Single 5 Volt power supply is all that is required.
- 1K BYTES OF 2114 STATIC RAM onboard with sockets provided for immediate expansion to 4K bytes onboard, with total memory expansion to 65, 536 bytes.
- USER PROM/ROM: The system is equipped with 3 PROM/ROM expansion sockets for 2316/2332 ROMs or 2716 EPROMs
- ENHANCED SOFTWARE with simplified user interface
- STANDARD INTERFACES INCLUDE:
  —Audio Cassette Recorder Interface with Remote Control (Two modes: 135 Baud KIM-1* compatible, Hi-Speed 1500 Baud)
  —Full duplex 20mA Teletype Interface
  —System Expansion Bus Interface
  —TV Controller Board Interface
  —CRT Compatible Interface (RS-232)
- APPLICATION PORT: 15 Bi-directional TTL Lines for user applications with expansion capability for added lines
- EXPANSION PORT FOR ADD-ON MODULES (51 I/O Lines included in the basic system)
- SEPARATE POWER SUPPLY connector for easy disconnect of the d-c power
- AUDIBLE RESPONSE KEYPAD



Synertek has enhanced KIM-1* software as well as the hardware. The software has simplified the user interface. The basic SYM-1 system is programmed in machine language. Monitor status is easily accessible, and the monitor gives the keypad user the same full functional capability of the TTY user. The SYM-1 has everything the KIM-1* has to offer, plus so much more that we cannot begin to tell you here. So, if you want to know more, the SYM-1 User Manual is available, separately

SYM-1 Complete w/manuals	**$229.00**
SYM-1 User Manual Only	**$7.00**
SYM-1 Expansion	**$60.00**

Expansion includes 3K of 2114 RAM chips and 1-6522 I/O chip.

SYM-1 Manuals: The well organized documentation package is complete and easy-to-understand.

SYM-1 CAN GROW AS YOU GROW. It's the system to BUILD-ON. Expansion features that are available:

BAS-1 8K Basic ROM (Microsoft Basic)	**$89.00**
KTM-2 (Complete terminal less monitor)	**$319.00**

QUALITY EXPANSION BOARDS DESIGNED SPECIFICALLY FOR KIM-1, SYM-1 & AIM 65

These boards are set up for use with a regulated power supply such as the one below, but, provisions have been made so that you can add onboard regulators for use with an unregulated power supply. But, because of unreliability, we do not recommend the use of onboard regulators. All I.C.'s are socketed for ease of maintenance. *All boards carry full 90-day warranty.*

All products that we manufacture are designed to meet or exceed industrial standards. All components are first qualtiy and meet full manufacturer's specifications. All this and an extended burn-in is done to reduce the normal percentage of field failures by up to 75%. To you, this means the chance of inconvenience and lost time due to a failure is very rare; but, if it should happen, we guarantee a turn-around time of less than forty-eight hours for repair.

Our money back guarantee: If, for any reason you wish to return any board that you have purchased directly from us within ten (10) days after receipt, complete, in original condition, and in original shipping carton; we will give you a complete credit or refund less a $10.00 restocking charge per board.

VAK-1 8-SLOT MOTHERBOARD

This motherboard uses the KIM-4* bus structure. It provides eight (8) expansion board sockets with rigid card cage. Separate jacks for audio cassette, TTY and power supply are provided. Fully buffered bus.

VAK-1 Motherboard **$139.00**

VAK-2/4 16K STATIC RAM BOARD

This board using 2114 RAMs is configured in two (2) separately addressable 8K blocks with individual write-protect switches.

VAK-2 16K RAM Board with only 8K of RAM (½ populated)	**$239.00**
VAK-3 Complete set of chips to expand above board to 16K	**$125.00**
VAK-4 Fully populated 16K RAM	**$325.00**

VAK-5 2708 EPROM PROGRAMMER

This board requires a +5 VDC and ±12 VDC, but has a DC to DC multiplyer so there is no need for an additional power supply. All software is resident in on-board ROM, and has a zero-insertion socket.

VAK-5 2708 EPROM Programmer **$249.00**

VAK-6 EPROM BOARD

This board will hold 8K of 2708 or 2758, or 16K of 2716 or 2516 EPROMs. *EPROMs not included.*

VAK-6 EPROM Board **$119.00**

VAK-7 COMPLETE FLOPPY-DISK SYSTEM $1299.00

See May Kilobaud for details

VAK-8 PROTYPING BOARD

This board allows you to create your own interfaces to plug into the motherboard. Etched circuitry is provided for regulators, address and data bus drivers; with a large area for either wire-wrapped or soldered IC circuitry.

VAK-8 Protyping Board **$39.00**

POWER SUPPLIES

ALL POWER SUPPLIES are totally enclosed with grounded enclosures for safety, AC power cord, and carry a full 2-year warranty.

FULL SYSTEM POWER SUPPLY

This power supply will handle a microcomputer and up to 65K of our VAK-4 RAM. ADDITIONAL FEATURES ARE: Over voltage Protection on 5 volts, fused, AC on/off switch. Equivalent to units selling for $225.00 or more.

Provides +5 VDC @ 10 Amps & ±12 VDC @ 1 Amp

VAK-EPS Power Supply **$119.00**

VAK-EPS/AIM—same as VAK-EPS but w/additional 24 volt unregulated (specifically for AIM 65) **$149.00**

KIM-1* Custom P.S. provides 5 VDC @ 1.2 Amps and +12 VDC @ .1 Amps

KCP-1 Power Supply **$39.00**

*KIM is a product of MOS Technology

Add $2.50 for shipping & handling for all except AIM 65.

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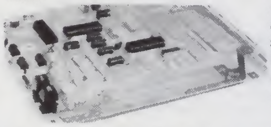
THE NEW EXPLORER/85 SYSTEM

Special! *Full 8" floppy, 64k system for less than the price of a mini! Only* $1499.95!

(Also available wired & tested, $1799.95)

Imagine — for only $129.95 you can own the starting level of Explorer/85, a computer that's expandable into full business/development capabilities — a computer that can be your beginner system, an OEM controller, or an IBM-formatted 8" disk small business system. From the first day you own Explorer/85, you begin computing on a significant level, and applying principles discussed in leading computer magazines. Explorer/85 features the advanced Intel 8085 cpu, which is 100% compatible with the older 8080A. It offers onboard S-100 bus expansion, Microsoft BASIC in ROM, plus instant conversion to mass storage disk memory with standard IBM-formatted 8" disks. All for only $129.95, plus the cost of power supply, keyboard/terminal and RF modulator if you don't have them (see our remarkable prices below for these and other accessories). With a Hex Keypad/display front panel, Level "A" can be programmed with no need for a terminal, ideal for a controller, OEM, or a real low-cost start.

Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)



Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use. $129.95

Level "A" With Hex Keypad/Display.

LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O . . . all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • **I/O:** Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader . . . cassette tape recorder input and output . . . cassette tape control output . . . LED output indicator on SOD (serial output) line . . . printer interface (less drivers) . . . total of four 8-bit plus one 6-bit I/O ports. • **Crystal Frequency:** 6.144 MHz. • **Control Switches:** Reset and user (RST 7.5) interrupt . . . additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • **Counter/Timer:** Programmable, 14-bit binary. • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems . . . RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000, leaving 0000 free for user RAM/ROM. Features include tape load with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point, a debugging/training feature . . . go to execution address . . . move blocks of memory from one location to another . . . fill blocks of memory with a constant . . . display blocks of memory . . . automatic baud rate selection to 9600 baud . . . variable display line length control (1-255 characters/line) . . . channelized I/O monitor routine with 8-bit parallel output for high-speed printer . . . serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling . . . tape dump with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point . . . go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

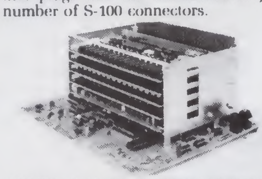
Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4k RAM expansion selectable in 4k blocks . . . address decoding for onboard 8k EPROM expansion selectable in 8k blocks . . . address and data bus drivers for onboard expansion . . . wait state generator (jumper selectable), to allow the use of slower memories . . . two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP. professional drive.
- LSI controller.
- Write protect.
- Single or double density.
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track).

DISK CONTROLLER/ I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives.
- 1771A LSI (SD) floppy disk controller.
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports
- Autoboot to disk system when system reset.
- 2716 PROM socket included for use in custom applications.
- Onboard crystal controlled.
- Onboard I/O baud rate generators to 9600 baud.
- Double-sided PC board (glass epoxy.)

DISK DRIVE CABINET/POWER SUPPLY

- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

ORDER A COORDINATED EXPLORER/85 APPLICATIONS PAK!

Beginner's Pak (Save $26.00!) — Buy Level "A" (Terminal Version) with Monitor Source Listing and AP-1 5-amp Power Supply: (regular price $199.95), now at SPECIAL PRICE: **$169.95** plus post. & insur.

Experimenter's Pak II (Save $53.40!) — Buy Level "A" (Hex Keypad/Display Version) with Hex Keypad/Display, Intel 8085 User Manual, Level "A" Hex Monitor Source Listing, and AP-1 5-amp Power Supply: (regular price $279.35), all at SPECIAL PRICE: **$219.95** plus post. & insur.

Special Microsoft BASIC Pak (Save $103.00!) — Includes Level "A" (Terminal Version), Level "B", Level "D" (4k RAM), Level "E", 8k Microsoft in ROM, Intel 8085 User Manual, Level "A" Monitor Source Listing, and AP-1 5-amp Power Supply: (regular price $439.70), now yours at SPECIAL PRICE: **$329.95** plus post. & insur.

ADD A TERMINAL WITH CABINET, GET A FREE RF MODULATOR: Save over $114 at this SPECIAL PRICE: **$499.95** plus post. & insur.

Special 8" Disk Edition Explorer/85 (Save over $104!) — Includes disk-version Level "A", Level "B", two S-100 connectors and brackets, disk controller, 64k RAM, AP-1 5-amp power supply, Explorer/85 deluxe steel cabinet, cabinet fan, 8" SD/DD disk drive from famous CONTROL DATA CORP. (not a hobby brand!), drive cabinet with power supply, and drive cable set-up for two drives. This package includes everything but terminal and printers (see coupon for them). Regular price $1630.30, all yours in kit at SPECIAL PRICE: **$1499.95** plus post. & insur. Wired and tested, only **$1799.95.**

Special! Complete Business Software Pak (Save $625.00!) — Includes CP/M 2.0, Microsoft BASIC, General Ledger, Accounts Receivable, Accounts Payable, Payroll Package: (regular price $1325), yours now at SPECIAL PRICE: **$699.95.**

Please send the items checked below:

- ☐ **Explorer/85 Level "A" kit** (Terminal Version) . . . **$129.95** plus $3 post. & insur.
- ☐ **Explorer/85 Level "A" kit** (Hex Keypad/Display Version) . . . **$129.95** plus $3 post. & insur.
- ☐ **8k Microsoft BASIC** on cassette tape, **$64.95** postpaid.
- ☐ **8k Microsoft BASIC in ROM kit** (requires Levels "B", "D" and "E") . . **$99.95** plus $2 post. & insur.
- ☐ **Level "B" (S-100) kit** . . **$49.95** plus $2 post. & insur.
- ☐ **Level "C" (S-100 6-card expander) kit** . . . **$39.95** plus $2 post. & insur.
- ☐ **Level "D" (4k RAM) kit** . . . **$69.95** plus $2 post. & insur.
- ☐ **Level "E" (EPROM/ROM) kit** . . . **$5.95** plus 50¢ p&h.
- ☐ **Deluxe Steel Cabinet** for Explorer/85 . . . **$49.95** plus $3 post. & insur.
  - ☐ Fan For Cabinet . . . **$15.00** plus $1.50 post. & insur.
- ☐ **ASCII Keyboard/Computer Terminal kit:** features a full 128 character set, u&l case; full cursor control; 75 ohm video output; convertible to baudot output; selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator) . . . **$149.95** plus $3.00 post. & insur.
  - ☐ **DeLuxe Steel Cabinet** for ASCII keyboard/terminal . . . **$19.95** plus $2.50 post. & insur.
- ☐ **New! Terminal/Monitor:** (See photo) Same features as above, except 12" monitor with keyboard and terminal is in deluxe single cabinet; kit . . . **$399.95** plus $7 post. & insur.
- ☐ **Hazeltine terminals:** Our prices too low to quote — **CALL US**
- ☐ **Lear-Sigler terminals/printers:** Our prices too low to quote. **CALL US**
- ☐ **Hex Keypad/Display kit** . . . **$69.95** plus $2 post. & insur.
- ☐ **AP-1 Power Supply Kit** ±8V @ 5 amps) in deluxe steel cabinet . . . **$39.95** plus $2 post. & insur.
- ☐ **Gold Plated S-100 Bus Connectors** . . . **$4.85** each, postpaid.
- ☐ **RF Modulator kit** (allows you to use your TV set as a monitor) . . . $8.95 **postpaid.**
- ☐ **16k RAM kit** (S-100 board expands to 64k) . . . **$199.95** plus $2 post. & insur.
- ☐ **32k RAM kit** . . . **$299.95** plus $2 post. & insur.
- ☐ **48k RAM kit** . . . **$399.95** plus $2 post. & insur.
- ☐ **64k RAM kit** . . . **$499.95** plus $2 post. & insur.
- ☐ **16k RAM Expansion kit** (to expand any of the above in 16k blocks up to 64k) . . . **$99.95** plus $2 post. & insur. each.
- ☐ **Intel 8085 cpu Users' Manual** . . . **$7.50** postpaid.
- ☐ **12" Video Monitor** (10MHz bandwidth) . . . **$139.95** plus $5 post. & insur.
- ☐ **Beginner's Pak** (see above) **$169.95** plus $4 post. & insur.
- ☐ **Experimenter's Pak** (see above) . . . **$219.95** plus $6 post. & insur.
- ☐ **Special Microsoft BASIC Pak Without Terminal** (see above) . . . **$329.95** plus $7 post. & insur.
- ☐ Same as above, plus **ASCII Keyboard Terminal With Cabinet, Get Free RF Modulator** (see above) . . . **$499.95** plus $10 post. & insur.
- ☐ **Special 8" Disk Edition Explorer/85** (see above) . . . **$1499.95** plus $26 post. & insur.
  - ☐ **Wired & Tested** . . . **$1799.95** plus $26 post. & insur.
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  - ☐ **Cabinet & Power Supply For Drive** . . . **$69.95** plus $3 post. & insur.
- ☐ **Drive Cable Set-up For Two Drives** . . . **$25** plus $1.50 post. & insur.
- ☐ **Disk Controller Board With I/O Ports** . . . **$199.95** plus $2 post. & insur.
- ☐ **Special: Complete Business Software Pak** (see above) . . **$699.96** postpaid.

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- ☐ **CP/M 1.4** . . . **$100** postpaid.
- ☐ **CP/M 2.0** . . . **$150** postpaid.
- ☐ **Microsoft BASIC** . . . **$325** postpaid.
- ☐ **Intel 8085 cpu User Manual** . . . $7.50 **postpaid.**
- ☐ **Level "A" Monitor Source Listing** . . . **$25** postpaid.

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SN7490N	.45
SN7491N	.59
SN7492N	.43
SN7493N	.43
SN7494N	.65
SN7495N	.65
SN7496N	.65
SN7497N	3.00
SN74100N	1.25
SN74107N	.35
SN74109N	.59
SN74116N	1.95
SN74121N	.35
SN74122N	.39
SN74123N	.59
SN74125N	.49
SN74126N	.49
SN74132N	.75
SN74136N	.75
SN74141N	.79
SN74142N	2.95
SN74143N	2.95
SN74144N	2.95
SN74145N	.79
SN74147N	1.95
SN74148N	1.29
SN74150N	1.25
SN74151N	.59
SN74152N	.59
SN74153N	.59
SN74154N	1.50
SN74155N	.79
SN74156N	.79
SN74157N	.65

SN74160N	.89
SN74161N	.89
SN74162N	1.95
SN74163N	.89
SN74164N	.89
SN74165N	.89
SN74166N	1.25
SN74167N	1.95
SN74170N	1.59
SN74172N	6.00
SN74173N	1.25
SN74174N	1.00
SN74175N	1.00
SN74176N	.79
SN74177N	.79
SN74179N	1.95
SN74180N	.79
SN74181N	1.95
SN74182N	.79
SN74184N	1.95
SN74185N	1.95
SN74186N	9.95
SN74188N	3.95
SN74190N	1.25
SN74191N	1.25
SN74192N	.79
SN74193N	.79
SN74194N	.89
SN74195N	.69
SN74196N	.89
SN74197N	.89
SN74198N	1.49
SN74199N	1.49
SN74S200	4.95
SN74251N	.99
SN74279N	.79
SN74283N	2.25
SN74284N	3.95
SN74285N	3.95
SN74365N	.69
SN74366N	.69
SN74367N	.69
SN74368N	.69
SN74390N	1.95
SN74393N	1.95

CMOS

CD4000	.39
CD4001	.39
CD4002	.39
CD4006	1.19
CD4007	.25
CD4009	.49
CD4010	.49
CD4011	.39
CD4012	.25
CD4013	.49
CD4014	1.39
CD4015	1.19
CD4016	.59
CD4017	1.19
CD4018	.99
CD4019	.49
CD4020	1.19
CD4021	1.39
CD4022	1.19
CD4023	.29
CD4024	.79
CD4025	.23
CD4026	2.95
CD4027	.69

CD4028	.89
CD4029	1.49
CD4030	.49
CD4035	.99
CD4040	1.49
CD4041	1.49
CD4042	.99
CD4043	.89
CD4044	.89
CD4046	1.79
CD4047	2.50
CD4048	1.35
CD4049	.49
CD4050	.69
CD4051	1.19
CD4053	1.19
CD4056	2.95
CD4059	9.95
CD4060	1.49
CD4066	.79
CD4068	.39
CD4069	.45

CD4070	.55
CD4071	.49
CD4072	.49
CD4076	1.39
CD4081	.39
CD4082	.39
CD4093	.99
CD4098	1.19
MC14409	14.95
MC14410	14.95
MC14411	14.95
MC14419	4.95
MC14433	13.95
MC14506	.75
MC14507	.99
MC14562	11.95
MC14583	2.49
CD4508	3.95
CD4510	1.39
CD4511	1.29
CD4515	2.95
CD4518	1.29
CD4520	1.29
CD4566	2.25

74C00

74C00	.39
74C02	.39
74C04	.45
74C08	.49
74C10	.39
74C14	1.95
74C20	.39
74C30	.39
74C42	1.95
74C48	2.49
74C73	.89
74C74	.89

74C85	2.49
74C90	1.95
74C93	1.95
74C95	1.95
74C107	1.25
74C151	2.90
74C154	3.00
74C157	2.15
74C160	2.49
74C161	2.49

74C163	2.49
74C164	2.49
74C173	2.60
74C192	2.49
74C193	2.49
74C195	2.49
74C922	7.95
74C923	6.25
74C925	8.95
74C926	8.95
80C95	1.50
80C97	1.50

LINEAR

78MG	1.75
LM106H	.99
LM300H	.80
LM301CN/H	.35
LM302H	.75
LM304H	1.00
LM305H	.60
LM307CN/H	.35
LM308CN/H	1.00
LM309H	1.10
LM309K	1.25
LM310CN	1.95
LM311N/H	.90
LM312H	1.95
LM317K	6.50
LM318CN/H	1.50
LM319N	1.30
LM320K-5	1.35
LM320K-5.2	1.35
LM320K-12	1.25
LM320K-15	1.35
LM320K-18	1.35
LM320K-24	1.35
LM320T-5	1.25
LM320T-5.2	1.25
LM320T-8	1.25
LM320T-12	1.25
LM320T-15	1.25
LM320T-18	1.25
LM320T-24	1.25
LM323K-5	5.95
LM324N	1.49
LM339N	.99
LM340K-5	1.35
LM340K-6	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35

LM340K-18	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-6	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM358N	1.00
LM370N	1.95
LM373N	3.25
LM377N	4.00
LM380N	1.25
LM380CN	.99
LM381N	1.79
LM382N	1.79
NE501N	8.00
NE510A	6.00
NE529A	4.95
NE531H/V	3.95
NE536T	6.00
NE540	6.00
NE544N	4.95
NE550N	1.30
NE555V	.39
NE556N	.99
NE560B	5.00
NE562B	5.00
NE565N/H	1.25
NE566CN	1.75
NE567V/H	.99
NE570N	4.95
LM703CN/H	.69
LM709N/H	.29

LM710N	.79
LM711N	.39
LM723N/H	.55
LM733N	1.00
LM739N	1.19
LM741CN/H	.35
LM741-14N	.39
LM747N/H	.79
LM748N/H	.39
LM1310N	1.95
LM1458CN/H	.59
MC1488N	1.95
MC1489N	1.95
LM1496N	.95
LM1556V	1.75
MC1741SCP	3.00
LM2111N	1.95
LM2901N	2.95
LM3053N	1.50
LM3065N	1.49
LM3900N(3401)	.59
LM3905N	1.49
LM3909N	1.25
MC5558V	.59
8038B	4.95
LM75450N	.49
75451CN	.39
75452CN	.39
75453CN	.39
75454CN	.39
75491CN	.79
75492CN	.89
75493N	.89
75494CN	.89
RC4136	1.25
RC4151	3.95
RC4194	4.95
RC4195	4.49

74LS00TTL

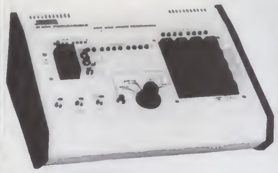
74LS00	.35
74LS01	.35
74LS02	.35
74LS03	.35
74LS04	.42
74LS05	.42
74LS08	.35
74LS09	.42
74LS10	.35
74LS11	.75
74LS13	.59
74LS14	1.25
74LS15	.35
74LS20	.35
74LS21	.35
74LS22	.35
74LS26	.35
74LS27	.35
74LS28	.35
74LS30	.35
74LS32	.42
74LS37	.45
74LS40	.35
74LS42	1.05
74LS47	1.05

74LS51	.29
74LS54	.29
74LS55	.29
74LS73	.54
74LS74	.54
74LS75	.71
74LS76	.54
74LS78	.49
74LS83	1.05
74LS85	1.50
74LS86	.54
74LS90	.71
74LS92	.90
74LS93	.90
74LS95	.99
74LS96	1.15
74LS107	.54
74LS109	.54
74LS112	.54
74LS123	1.50
74LS125	1.05
74LS132	.99
74LS136	.59
74LS138	1.05

74LS139	1.05
74LS151	1.05
74LS155	1.05
74LS157	1.05
74LS160	1.15
74LS161	1.39
74LS162	1.25
74LS163	1.39
74LS164	1.50
74LS175	1.25
74LS181	2.49
74LS190	1.39
74LS191	1.39
74LS192	1.39
74LS193	1.39
74LS194	1.39
74LS195	1.39
74LS253	1.25
74LS257	1.05
74LS258	1.75
74LS260	.83
74LS279	.90
74LS367	.75
74LS368	.75
74LS670	2.49

JE608 PROGRAMMER

2704/2708 EPROM PROGRAMMER



- 3 separate Display Registers 8 LED's for Hex Key entries, 10 LED's (2' 2') for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip.
- Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board.
- Rapid checking verification of programmed data changes.
- User may move data from a master to RAM's or write into RAM's with keyboard entries.
- Allows manual stepping manipulation (up and down) at any address location.
- Stand alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W.
- Compact desk top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.

The **JE608** EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program, for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board with 25 IC's and including power supplies of −5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel Board are separate assemblies within the system.

JE608 KIT **$399.95**
JE608 Assembled and Tested **$499.95**

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1	XC111R	.190"	red	5/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1	XC111G	.190"	green	4/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1	XC111Y	.190"	yellow	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1	XC111C	.190"	clear	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1				
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1	INFRA-RED LED			
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1	¼"x ¼"x 1/16" flat			5/$1
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1				

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	630	1.49
MAN 4610	Common Anode-orange	.400	.99	DL750	Common Cathode-red	600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	800	1.50
MAN 6650	Common Cathode-orange ± 1	560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	600	19.95
MAN 6660	Common Anode-orange	560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (± 1)	600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	3.25	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	1.25	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7-seg. LED driver	1.50
MM5309	4.95

CLOCK CHIPS

MM5309	4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998a	4.95
CT 7001	6.95

MOTOROLA

MC1408L7	4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016 (74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

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ASST. 2	5 ea	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

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ICM7205	CMOS LED Stopwatch/Timer	19.95
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TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
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MM5320	TV Camera Sync. Generator	14.95
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XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4733	5.1	1w	.28
1N965	15	400m	4/1.00	1N4734	5.6	1w	.28
1N5232	5.6	500m	.28	1N4735	6.2	1w	.28
1N5234	6.2	500m	.28	1N4736	6.8	1w	.28
1N5235	6.8	500m	.28	1N4738	8.2	1w	.28
1N5236	7.5	500m	.28	1N4742	12	1w	.28
1N5242	12	500m	.28	1N4744	15	1w	.28
1N5245	15	500m	.28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
		2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.035	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.39	.31	.25	1.5/35V	.41	.33	.26
.15/35V	.39	.31	.25	2.2/35V	.51	.41	.33
.22/35V	.39	.31	.25	3.3/25V	.53	.43	.34
.33/35V	.39	.31	.25	4.7/25V	.63	.51	.41
.47/35V	.39	.31	.25	6.8/25V	.79	.63	.50
.68/35V	.39	.31	.25	15/25V	1.39	1.12	.89
1.0/35V	.39	.31	.25	22/6V	.79	.63	.50

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
47/50V	15	13	10	47/25V	15	13	10
1.0/50V	16	14	11	47/50V	16	14	11
3.3/50V	14	12	09	1.0/16V	15	13	10
4.7/25V	15	13	10	1.0/25V	16	14	11
10/25V	15	13	10	1.0/50V	16	14	11
10/50V	16	14	12	4.7/16V	15	13	10
22/25V	17	15	12	4.7/25V	15	13	10
22/50V	24	20	18	4.7/50V	16	14	11
47/25V	19	17	15	10/16V	14	12	09
47/50V	25	21	19	10/25V	15	13	10
100/25V	24	20	18	10/50V	16	14	12
100/50V	35	30	28	47/50V	24	21	19
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	41	38	100/25V	24	20	18
470/25V	33	29	27	100/50V	35	30	28
1000/16V	55	50	45	220/16V	23	17	16
2200/16V	70	62	55	470/25V	31	28	26

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New Summer 1980
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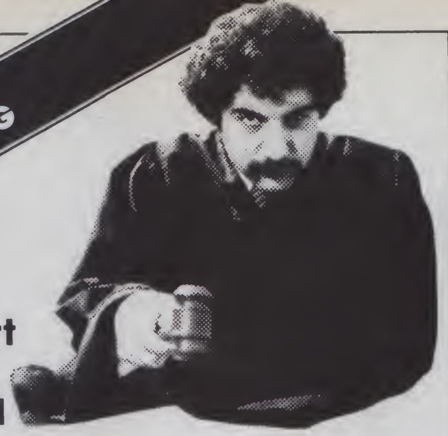

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with 10 day free return

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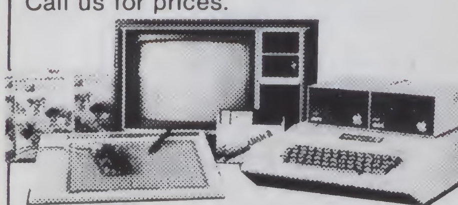
Apple Computer—We have a complete inventory of Apple computers, peripherals and software—In stock for immediate delivery—Call us for prices.



apple computer

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Buy Direct from the largest Commodore dealer in the country, and the very first Commodore distributor in the U.S. Buy from the experts- Buy from CompuMart.

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(1) Buy additional memory for your computer, 8K or 16K, and we will double the amount of memory FREE! (A potenial savings of $200)

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Comes with:
- 800 Operator's Manual
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ATARI

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COMPUMART NOW OFFERS THE ENTIRE DEC LSI-11 PRODUCT LINE. CALL FOR PRICES & DELIVERY.

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Save $300 on this 16-Bit computer with monitor

TI-99/4 w/Monitor	**$825**
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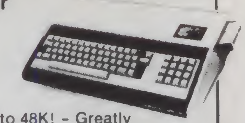
FREE 9" Sanyo Monitor with purchase of any Exidy Sorcerer Computer.
$159 VALUE!



The Magicians Have Done It Again with the Sorcerer II . . . Expandable to 48K! – Greatly enhanced word processing capabilities.

16K Sorcerer II	**$1,245**
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S-100 Expansion Unit	**$419**
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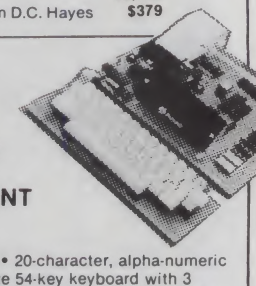
Micromodem 100 from D.C. Hayes	**$379**

ROCKWELL AIM 65

THE SINGLE BOARD DEVELOPMENT SYSTEM



6502 Microprocessor • 20-character, alpha-numeric LED display • Full-size 54-key keyboard with 3 user-defined functions • Fast, on-board 20-column thermal printer • 8K Advanced Interactive Monitor program • Dual cassette interface board • On-board timer • On-board ROM expansion to 12K • 4K on-board RAM • On-board TTY interface • 16 parallel I/0 lines • One serial I/0 port • KIM compatible edge connectors for even further memory or I/0 expansion.

The CompuMart AIM System combines all of our options for the AIM to give you the capabilities of development systems costing 5 to 10 times as much. This system includes a 4K AIM 65 with BASIC and Assembler, and MTU power supply, a Sanyo tape recorder and an EGI Enclosure for the AIM.

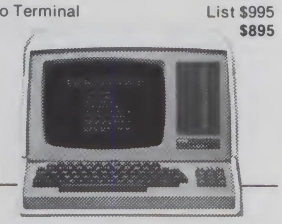
CompuMart Aim System	**$850.00**
4K AIM-65	**$515.00**
Paper for the AIM	**$4.75**

Zenith Z-89

The All-In-One-Computer

This is the famous computer system which takes up no more space than a terminal alone. The 12" screen is beautiful and lends itself perfectly to professional applications thanks to its 25 lines of 80 characters. We know of no other computer which gives you this many features at such a low price.

Zenith 48K Z-89 Dual Port	List $2,895
CompuMart	**$2,695**
Z-19 Smart Video Terminal	List $995
CompuMart	**$895**



Introducing the HP-85 $3,250

Hewlett-Packard's Personal Computer for Industry. This extremely portable computer features extended BASIC to solve your problems quickly and efficiently along with an advanced graphics system to enhance communication.

New from Novation! -D-CAT

The only direct modem that's FCC approved for hardset jack connection with any modular phone. **$199**

NOVATION CAT™

ACCOUSTIC MODEM

- Answer Originate
- 300 Baud
- Bell 108
- Low Profile Design

Looks good, works great! $179.00

Terminals

Televideo 912C
820 × 24—Lower case descenders. Teletype or telewriter keyboard. 110/220 VAC. 50 to 19.2K Baud Item entry pad. Great looking and no fan noise. **$950**

Televideo 920C
Similar to the TV 912 but has programmable function keys across top.
Excellent for text editing. **$1,030**

We've got the following Lear Siegler Terminals In Stock at prices too low to print—**Call** for quotes.

ADM-3A Industries favorite dumb terminal for some very smart reasons.
ADM-3A.+ New from Lear Siegler. CALL!
ADM-31. The terminal that's too smart to be considered dumb.
ADM-42. Available with keyboard or without, semi-intelligent terminal offering tremendous user flexibility. The optional configurations are amazing.

Call for details.

HAZELTINE TERMINALS AT SPECTACULAR SAVINGS!

Hazeltine 1410.	List $850	**CompuMart $749**
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Hazeltine 1500.	List $1095	**CompuMart $995**
Hazeltine 1510.	List $1395	**CompuMart $1325**
Hazeltine 1520.	List $1585	**CompuMart $1485**
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Call CompuMart for complete specs and quantity discounts.

Calculators

A CALCULATOR, A SYSTEM, A WHOLE NEW STANDARD.

HEWLETT-PACKARD'S HP-41C

HP-41C Calculator **$288.00**
The System
Memory Modules. For storing programs or up to 2,000 lines of program memory **$45.00**
"Extra Smart" Card Reader. Records programs and data back onto blank mag-cards **$199.00**
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Application Modules . . . . **$45.00 EACH**
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Math,
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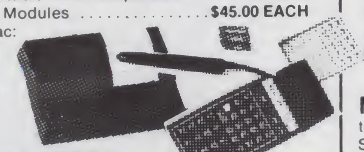


TI CALCULATORS ·

Three of the finest from the first.
Programmable 59 . . . SUPER SALE $229

TI-58c Programmable Calculator (W/continuous memory) **$104.00**
TI Programmer **$59.00**
Add convenient versatile printing capabilities to your TI Programmable 58C or 59 calculator with the PC-100C thermal printer, plotter.
TI PC-100C **$168.00**
TI Talking Translator. The calculator actually speaks! **$300.00**

CompuMart judges Mountain Hardware the Buy–of–the–Month.

CompuMart Exclusive Expansion Accessories for Your Apple from

Mountain Hardware

For the ultimate in energy saving devices for your home get the BSR X-10. This system allows you to remotely control lights and electrical appliances in your home. The CompuMart package comes complete with Mountain Hardware software allowing your Apple to control home devices on a predetermined schedule.
Introl/X-10 System **$289**
Let your Apple speak to you thru the amazing Supertalker. This device outputs high-quality human speech via a loudspeaker. Comes complete with the SuperTalker Peripheral Card, a microphone, loudspeaker, software, and two programs.
SuperTalker **$299**

The most advanced computerized composing system available — **The Music System — $545**

Give your Apple powerful new capabilities with the **ROMplus board — $199 w/keyboard filter.**

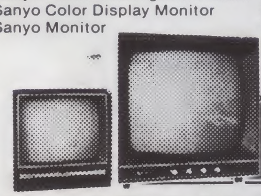
New From Microsoft The Z-80 SoftCard
Just plug the Z-80 SoftCard into your Apple and instantly you will have more versatility than any other computer user. The Z-80 SoftCard package allows you to add FORTRAN, COBOL, and BASIC as versions are introduced over the next few months. With this card you can run any standard LP/M software and much more. Call us and we'll tell you exactly how much more.
Z-80 SoftCard, LP/M Operating System, and Microsoft Disk BASIC Interpreter — **$349**

Monitors

EXCLUSIVE from CompuMart!
Special Offer. Zenith Color Video Monitor for $379!
The perfect monitor for Apple, Atari and Texas Instruments owners.

NEW FROM SANYO — Four Great Monitors at Low CompuMart Prices.
Sanyo's new line of CRT data display monitors are specifically designed for the display of alphanumeric or graphic data.

9″ Sanyo Monitor	**$159**
12″ Sanyo Monitor	**$289**
12″ Sanyo Monitor with green screen	**$299**
13″ Sanyo Color Display Monitor	**$495**
15″ Sanyo Monitor	**$269**



Printers

CompuMart STOCKS THE COMPLETE LINE OF MATROX PRODUCTS. CALL FOR SPECS.

Only the Best in Quality, Selection, and Service.

The Paper Tiger Printer From Integral Data
Uses standard ⅜ inch roll paper and ribbon
40 characters per line
Speed: 40 characters per second
UL approved
High resolution dot matrix impact printer

Roar!

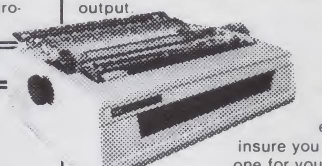
Standard features include: 4 character 8.3 to 16.5 cpi • 56 cps at 10 char. per in. • Selectable line spacing • 8 switch-selectable form sizes.
The IDS Graphics Option for the Paper Tiger allows full dot pattern control and includes and expanded 2048-byte buffer (a 256-type buffer is standard).
IDS Paper Tiger Printer **$995**
IDS Graphics Paper Tiger Printer **$1,094**

NEW! From Integral Data. The IDS 460.
We saw this new desktop printer at the NCC 80 and when we saw its features: Correspondence quality printing, High-resolution graphics capability, programmable print control functions, and automatic text justification—we knew that we had to offer this printer to our cost/features conscious customers $1,295

CENTRONICS PRINTERS
New! The incredible Model 737- Correspondence and Draft Quality Printing for Under $1,000. This is the first printer in its class to offer print quality suitable for text processing, plus the performance and application flexibility required for data processing. **$995**

Tractor Feed Printer- Centronics' Most Popular Model. Perfect for the needs of a small business sytesm. Recommended by Apple and Radio Shack. **$1,079**

NEC The First Name in Letter Quality Printers.
CompuMart offers beautiful print quality with NEC Spinwriter terminals. The Spinwriters, both KSR and RO versions, give unsurpassed hard copy output.



CompuMart offers a complete range of NEC Spinwriters—Call our expert salesforce to insure you get the right one for your system.

IMPORTANT ORDERING INFORMATION All orders must include 4% shipping and handling. Mass. residents add 5% sales tax. Mich. residents 4% for sales tax

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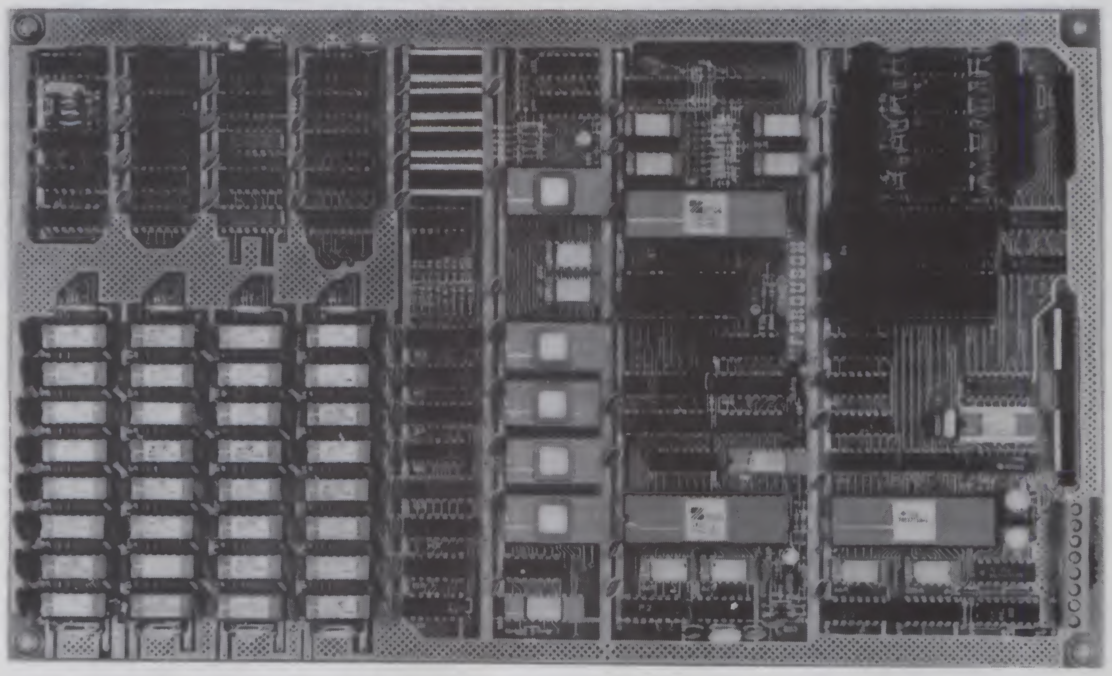
NEW! NEW!

"THE BIG BOARD"

OEM - INDUSTRIAL - BUSINESS - SCIENTIFIC

SINGLE BOARD COMPUTER KIT!

Z-80 CPU! 64K RAM!



THE FERGUSON PROJECT: Three years in the works, and maybe too good to be true. A tribute to hard headed, no compromise, high performance, American engineering! The Big Board gives you all the most needed computing features on one board at a very reasonable cost. The Big Board was designed from scratch to run the latest version of CP/M*. Just imagine all the off-the-shelf software that can be run on the Big Board without any modifications needed! Take a Big Board, add a couple of 8 inch disc drives, power supply, and an enclosure; and you have a total Business System for about 1/3 the cost you might expect to pay.

$649.00** (64K KIT BASIC I/O)

SIZE: 8½ x 13¾ IN.
SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
+ - 12V @ .5 AMPS.

FEATURES: (Remember, all this on one board!)

64K RAM

Uses industry standard 4116 RAM'S. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

Z-80 CPU

Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERUPTS. Fully buffered and runs 8080 software.

SERIAL I/O (OPTIONAL)

Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232! For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: $85.

BASIC I/O

Consists of a separate parallel port (Z80 PIO) for use with an ASCII encoded keyboard for input. Output would be on the 80 x 24 Video Display.

80 x 24 CHARACTER VIDEO

With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true.

FLOPPY DISC CONTROLLER

Uses WD1771 controller chip with a TTL Data Separator for enhanced reliability. IBM 3740 compatible. Supports up to four 8 inch disc drives. Directly compatible with standard Shugart drives such as the SA800 or SA801. Drives can be configured for remote AC off-on. Runs CP/M* 2.2.

FOUR PORT PARALLEL I/O (OPTIONAL)

Uses Z-80 PIO. Full 16 bits, fully buffered, bi-directional. User selectable hand shake polarity. Set of all parts and connectors for parallel I/O: $29.95

REAL TIME CLOCK (OPTIONAL)

Uses Z-80 CTC. Can be configured as a Counter on Real Time Clock. Set of all parts: $14.95

SYSTEM COMPARISON	
64K RAM KIT	$370.00
80 x 24 Video Kit	365.00
Floppy Disk Controller Kit	235.00
Z-80 CPU Kit	185.95
SER & PAR. I/O	129.95
S-100 Mother Board	45.00
SUB TOTAL	$1330.90

Talk about bangs per buck! The prices shown for S100 kits were taken from the July 1980 BYTE. This will give some basis for comparison between the Big Board and a similar system implementation on the S100 Buss.

CP/M* 2.2 FOR BIG BOARD

The popular CP/M* D.O.S. modified by MICRONIX SYSTEMS to run on Big Board is available for $150.00.

FIRST TIME OFFERED!

PFM 3.0 2K SYSTEM MONITOR

The real power of the Big Board lies in its PFM 3.0 on board monitor. PFM commands include: Dump Memory, Boot CP/M*, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I/O Ports, Disc Read (Drive, Track, Sector), and Search. PFM occupies one of the four 2716 EPROM locations provided. It does not occupy any of the 64K of system RAM!

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(OF TEXAS)

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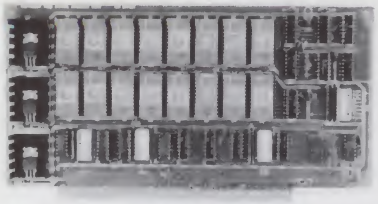
TERMS: Initial shipments will be made approximately 3 to 5 weeks after we receive your order. VISA, MC, cash accepted. We will accept COD's (for the Big Board only) with a $75 deposit. Balance UPS COD. The $75 deposit assures your place in line for the initial production run of Big Board.

*TRADEMARK OF DIGITAL RESEARCH. NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE SUPPLIERS OF CPM SOFTWARE

** 1 TO 4 PIECE DOMESTIC USA PRICE.

DIGITAL RESEARCH COMPUTERS
(214) 271-3538

32K S-100 EPROM CARD
NEW!



$74.95
KIT

USES 2716's

Blank PC Board - $34

ASSEMBLED & TESTED ADD $30

SPECIAL: 2716 EPROM's (450 NS) Are $19.95 EA. With Above Kit.

KIT FEATURES:
1. Uses +5V only 2716 (2Kx8) EPROM's.
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible.
4. Addressable as two independent 16K blocks.
5. Cromemco extended or Northstar bank select.
6. On board wait state circuitry if needed.
7. Any or all EPROM locations can be disabled.
8. Double sided PC board, solder-masked, silk-screened.
9. Gold plated contact fingers.
10. Unselected EPROM's automatically powered down for low power.
11. Fully buffered and bypassed.
12. Easy and quick to assemble.

16K DYNAMIC RAM PARTIALS
LOOK! **INTEL 2108 8K X 1 RAMS** LOOK!
8 FOR $9.95 32 FOR $35
FACTORY PRIME!

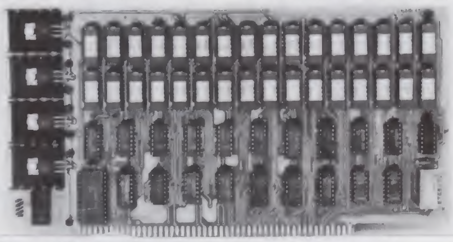
Huge special purchase of INTEL Dynamic RAM's. These are 2108-4, 300NS, 8K, Ceramic DIP. The 2108 is the INTEL 2116 (16K) tested for either upper or lower 8K only. These are factory prime. Full Spec. See INTEL 1978 Cat. for details or Memory Design Handbook for application data. Both IMSAI and EXTENSYS did mfg. S-100 RAM boards using these devices. — P.S. These devices will not work in the SD EPANDORAM™. Please specify upper or lower 8K. (S1626 or S1627). A super easy RAM to interface to a Z80, 16 PIN DIP.

FOR 4MHZ **SALE!** **LOW POWER - 300NS** **8 FOR $44**
2114 RAM SALE!
4K STATIC RAM'S. MAJOR BRAND, NEW PARTS.
These are the most sought after 2114's, LOW POWER and 300NS FAST.
8 FOR $44

16K STATIC RAM KIT-S 100 BUSS

PRICE CUT!
$225 KIT

FOR 4MHZ ADD $10



KIT FEATURES:
1. Addressable as four separate 4K Blocks
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!). Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 1.5 amps TYPICAL from the +8 Volt Buss
10. Blank PC Board can be populated as any *multiple of 4K*.

BLANK PC BOARD W/DATA-**$33**
LOW PROFILE SOCKET SET-**$12**
SUPPORT IC'S & CAPS-**$19.95**
ASSEMBLED & TESTED-**ADD $35**

OUR #1 SELLING RAM BOARD!

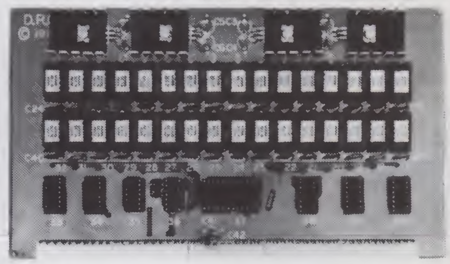
16K STATIC RAM SS-50 BUSS

PRICE CUT!

$229 KIT

FULLY STATIC!

FOR 2MHZ ADD $10



FOR SWTPC 6800 BUSS!

ASSEMBLED AND TESTED - $35

KIT FEATURES:
1. Addressable on 16K Boundaries
2. Uses 2114 Static Ram
3. Fully Bypassed
4. Double sided PC Board. Solder mask and silk screened layout
5. All Parts and Sockets included
6. Low Power: Under 1.5 Amps Typical

BLANK PC BOARD—**$30** COMPLETE SOCKET SET—**$12**
SUPPORT IC'S AND CAPS—**$19.95**

NEW! **STEREO!** NEW!
S-100 SOUND COMPUTER BOARD

At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY3-8910 NMOS computer sound IC's. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE, etc.

COMPLETE KIT! $84.95 (WITH DATA MANUAL)

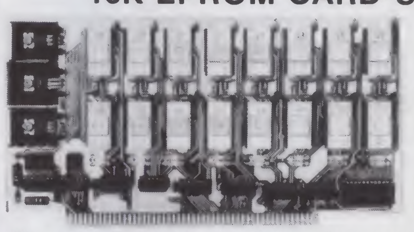
BLANK PC BOARD W/DATA $31

KIT FEATURES:
- ★ TWO GI SOUND COMPUTER IC'S.
- ★ FOUR PARALLEL I/O PORTS ON BOARD.
- ★ USES ON BOARD AUDIO AMPS OR YOUR STEREO.
- ★ ON BOARD PROTO TYPING AREA.
- ★ ALL SOCKETS, PARTS AND HARDWARE ARE INCLUDED.
- ★ PC BOARD IS SOLDERMASKED, SILK SCREENED, WITH GOLD CONTACTS.
- ★ EASY, QUICK, AND FUN TO BUILD. WITH FULL INSTRUCTIONS.
- ★ USES PROGRAMMED I/O FOR MAXIMUM SYSTEM FLEXIBILITY.

Both Basic and Assembly Language Programming examples are included.

SOFTWARE:
SCL™ is now available! Our Sound Command Language makes writing Sound Effects programs a SNAP! SCL™ also includes routines for Register-Examine-Modify, Memory-Examine-Modify, and Play-Memory. SCL™ is available on CP/M* compatible diskette of 2708 or 2716. Diskette - **$24.95** 2708 - **$19.95** 2716 - **$29.95** Diskette includes the source. EPROM'S are ORG at E000H.

16K EPROM CARD-S 100 BUSS



$59.95 KIT

BLANK PC BOARD - $28

USES 2708's!

Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at **ALL TIMES!** Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

ASSEMBLED AND FULLY TESTED — ADD $30

OUR 450 NS 2708'S ARE $8.95 EA. WITH PURCHASE OF KIT

RCA CMOS COMPUTER CHIP SET
INCLUDES:

1-CDP1802CD CPU	1-CDP1861CD VIDEO IC
2-CDP1822CE 256 x 4 RAM	1-CDP1862CE COLOR GEN.
1-CDP1858CE 4 BIT LATCH	1-CDP1863CE SOUND GEN.

COMPLETE SET $45 LIMITED QTY

NEW! G.I. COMPUTER SOUND CHIP

AY3-8910. As featured in July, 1979 BYTE! A fantastically powerful Sound & Music Generator. Perfect for use with any 8 Bit Microprocessor. Contains: 3 Tone Channels, Noise Generator, 3 Channels of Amplitude Control. 16 bit Envelope Period Control, 2-8 Bit Parallel I/O. 3 D to A Converters, plus much more! All in one 40 Pin DIP. Super easy interface to the S-100 or other busses.

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LIGHT PEN

Comes with Backgammon and Tic-Tac-Toe on tape with full documentation and program listing. Requires 9v. battery. Part No. IBEX $19.95

PET COMPUTER

With 16K & monitor—$895.00 • Dual Disk Drive —$1095.00

PARALLEL TRIAC OUTPUT BOARD FOR APPLE II

This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only $15.00 Part No. 210, with parts $119.95 Part No. 210A

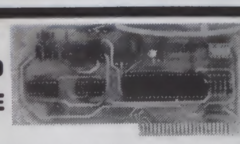
D.C. HAYES MICROMODEM

Fully S-100 bus compatible including 16-bit machines and 4 MHz processors. • Two software selectable Baud rates—300 Baud and a jumper selectable speed from 45 to 300 Baud. (110 standard). Supports originate and answer modes. • Direct-connect Microcoupler. This FCC-registered device provides direct access into your local telephone system, with none of the losses or distortions associated with acoustic couplers and without a telephone company supplied data access arrangement. • Auto-Answer/Auto-Call. The MICROMODEM 100 can automatically answer the phone and receive input; it can also dial a number automatically. • Automatic Reset and Disconnect. • Software compatible with the D.C. Hayes Associates 80-103A Data Communications Adapter. Micromodem-DCHA32625—$379.95

APPLE II HOBBY/ PROTOTYPING CARD

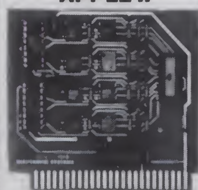
Part No. 7907 $14.95

APPLE II SERIAL I/O INTERFACE



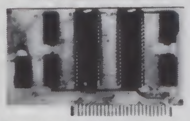
Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches DTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

OPTO-ISOLATED PARALLEL INPUT BOARD FOR APPLE II



There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection. Board only $15.00. Part No. 120, with parts $69.95. Part No. 120A.

APPLE II PARALLEL INTERFACE



Interfaces printers, synthesizers keyboards, and JBE A-D D-A Converter & Switches. This interface has 4 I/O ports with handshaking logic, 2-6522 VIA's and a 74LS74 for timing. Inputs and outputs are TTL compatible. Part No. 79295K Complete Kit—$69.95 • Part No. 79295A Assembled—$79.95

TIDMA

Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate • S-100 bus compatible • Board only $35.00 Part No. 112, with parts $110.00 Part No. 112A.

SYSTEM MONITOR

8080, 8085, or Z-80 System monitor for use with the TIDMA board. There is no need for the front panel. Complete with documentation $12.95.

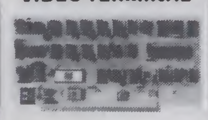
8K EPROM PICEON

• Programs 2708's address relocation of each 4K of memory to any 4K boundary • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.

REAL TIME 100,000 DAY CLOCK

MT. HARDWARE Double the utility of your S-100 bus computer with a real-time clock that keeps time in 100µS increments for over 273 years. Program events for the entire period with real time interrupts...without derailing the system. Maintain a log of computer usage, time and date transaction printouts, call up lists. On-board battery backup. MHPX004— $349.00

VIDEO TERMINAL

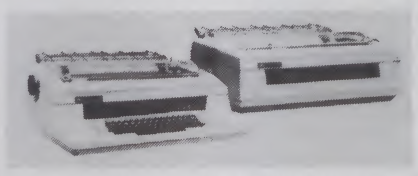


16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • Serial RS-232 in and out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & −16 VDC at 100mA, and 8VDC at 1A. Part No. 1000A $199.95 kit.

16K EPROM

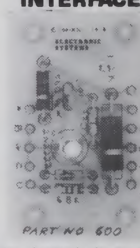
Uses 2708 EPROMS, memory speed selection provided, addressable anywhere in 65K of memory, can be shadowed in 4K increments. Board only $24.95 part no. 7902, with parts less EPROMs $49.95 part no. 7902A.

SPINWRITER MODELS 5510 and 5520



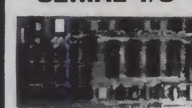
Features—EIA RS-232C/CCITT V.24 Interface Standard • 55 Characters Per Second Maximum Print Rate • Impeccable Print Quality (OCR Quality) • Microprocessor Electronics • High Resolution Plotting/Graphing • Lowest Operating Noise Level • Self-Test Printing • Operator Engineered Control Panel • Prints Original and up to Seven Copies • NEC Information Systems new Model 5510 Receive Only and Model 5520 Keyboard Send/Receive SPINWRITER terminals are microprocessor controlled serial, impact terminals designed for remote printing applications where impeccable print quality is required. Model 5510 RO, Part No. NECA30759 $2795.95 • Model 5520 KSR, Part No. NECA30762 $3095.95

RS-232/TTY INTERFACE



This board has two active circuits, one converts RS-232 to 20 mA, the other converts 20 mA to RS-232. Requires +12 and -12 volts. $9.95 Part No. 600A Kit.

SERIAL I/O



Four Serial I/O RS-232 ports. S-100 Bus, Software or jumper selectable baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19.2K), on board Xtal baud rate generator, Addressing, switch selectable, Parity or no parity (odd or even) switch selectable, 1 or 2 stop bits, 5 to 8 bits/character. Board only $29.95, Part No. 7908. With parts (kit) $199.95, Part No. 7908A.

S-100 BUS ACTIVE TERMINATOR

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A

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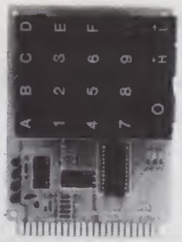
HEX ENCODED KEYBOARD



Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX- 3A. 44 pin edge connector $4.00 Part No. 44P.

ASCII TO CORRESPONDENCE CODE CONVERTER

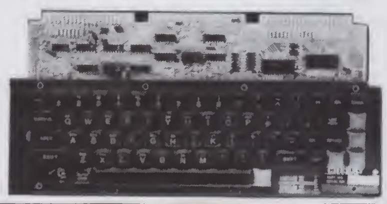
This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for $249.95. Part No. TA 1000C

ASCII KEYBOARD

53 Keys popular ASR-33 format • Rugged G-10 P. C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. $59.95 Kit.

ASCII KEYBOARD

TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. $119.95.



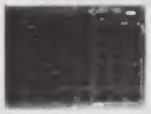
T.V. INTERFACE

• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple • Power required is 12 volts AC C.T., or +5 volts DC • Board only $7.60 part No. 107, with parts $13.50 Part No. 107A

TAPE INTERFACE

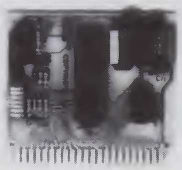
• Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board only $7.60 Part No. 111, with parts $29.95Part No. 111A

T.V. TYPEWRITER



• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A

UART & BAUD RATE GENERATOR

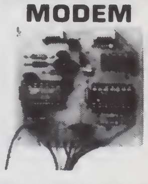


• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P

SOROC IQ 120

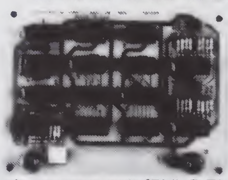
Upper/lower case display • Numeric keypad & cursor keys • Protected fields, ½ intensity display • RS 232 interface & aux. port. IQ120—$799.95 • IQ140 Detachable keyboard—$1199.95

MODEM



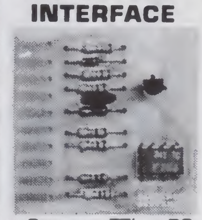
• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • Serial TTL input and output • connect 8 Ω speaker and crystal mic. directly to board • Requires +5 volts • Board only $7.60 Part No. 109, with parts $29.95 Part No. 109A.

A-to-D D-to-A CONVERTER



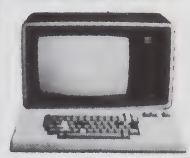
Analog to Digital, Digital to Analog Converter, A-D conversion time 20us. D-A conversion 5us. Uses include speech and music synthesizing and slow scan TV. Single power supply (5V), 8 Bits wide, latched I/O, strobe lines. Part No. 79287K Complete Kit $49.95 • Part No. 79287A Assembled $69.95

RS-32/TTL INTERFACE



• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin edge connector, kit $9.95 Part No.232A 10 Pin edge connector $3.00 part No. 10P.

COMPUCOLOR II



With reg. keyboard
MOD3 8K $1449.95
MOD4 16 K $1495.95
MOD5 32K $1699.95
Without disk drive subtract $450.00. Add-on drives, $495.00. With 101 key option add $134.95. With 117 key option add $179.95.

44 BUS MOTHER BOARD

Has provisions for ten 44 pin (.156) connectors, spaced 3/4 of an inch apart. Pin 20 is connected to X, and 22 is connected to Z for power and ground. All the other pins are connected in parallel. This board also has provisions for bypass capacitors. Board cost $15.00 Part No. 102. Connectors $3.00 each Part No. 44WP.

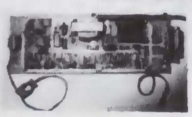
RS-232/20mA INTERFACE

This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only $9.95, part no. 7901, with parts $14.95 Part No. 7901A.

SOLID STATE SWITCH

Your computer can control power (120VAC) to your printer, lights, and other 120VAC appliances up to 720 watts (6AMPS at 120VAC). Input 3 to 15 VDC, 2-13 MA TTL compatible, isolation 1500V. Part No. 79000K 1 Channel Kit $9.95 • Assm. $12.50 • Part No. 79004K 4 Channel Kit $34.95 • Assm. $44.95.

SUPER MODEM



Orignate, RS-232 and 20 mA compatable, Full duplex, and half duplex, direct connect or acoustic coupled, on board power supply, carrier detect light, DB25 plug, 300 BAUD, Type 103 compatable frequencies, Bare board Part No. 2000, $19,95, Kit Part No. 2000A, $99.95.

DC POWER SUPPLY

• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A

Send for FREE Catalog...a big self addressed envelope with 80¢ postage gets it fastest!

To Order: Mention part no., description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders (U.S. only) or a VISA or Master Charge no., expiration date, signature and phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 15% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. Prices subject to change without notice.

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7400

SN7400N	19	SN74123N	59
SN7401N	22	SN74125N	39
SN7402N	22	SN74126N	44
SN7403N	22	SN74128N	59
SN7404N	22	SN74132N	69
SN7405N	23	SN74136N	95
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	69
SN7408N	26	SN74142N	2.95
SN7409N	23	SN74143N	2.95
SN7410N	22	SN74144N	2.95
SN7411N	29	SN74145N	62
SN7412N	29	SN74147N	1.95
SN7413N	39	SN74148N	1.20
SN7414N	59	SN74150N	99
SN7416N	29	SN74151N	67
SN7417N	29	SN74152N	67
SN7420N	22	SN74153N	67
SN7421N	35	SN74154N	1.19
SN7422N	29	SN74155N	82
SN7423N	29	SN74156N	89
SN7425N	29	SN74157N	69
SN7426N	29	SN74158N	1.65
SN7427N	29	SN74160N	95
SN7429N	45	SN74161N	95
SN7430N	23	SN74162N	89
SN7432N	29	SN74163N	87
SN7437N	29	SN74164N	97
SN7438N	29	SN74165N	97
SN7439N	29	SN74166N	1.20
SN7440N	24	SN74167N	1.95
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SN7446N	79	SN74176N	85
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SN7448N	79	SN74179N	1.80
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SN7472N	34	SN74190N	1.15
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SN7475N	38	SN74193N	85
SN7476N	36	SN74194N	85
SN7479N	4.60	SN74195N	85
SN7480N	59	SN74196N	85
SN7481N	1.10	SN74197N	85
SN7482N	1.10	SN74198N	1.39
SN7483N	55	SN74199N	1.39
SN7485N	65	SN74221N	1.39
SN7486N	39	SN74251N	95
SN7489N	1.75	SN74273N	1.05
SN7490N	39	SN74279N	89
SN7491N	65	SN74283N	2.15
SN7492N	52	SN74284N	3.90
SN7493N	49	SN74285N	3.90
SN7494N	72	SN74290N	1.25
SN7495N	65	SN74298N	95
SN7496N	72	SN74365N	68
SN7497N	3.10	SN74366N	68
SN74100N	99	SN74367N	79
SN74107N	32	SN74368N	79
SN74109N	53	SN74390N	1.90
SN74116N	1.95	SN74393N	1.90
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CD4051	1.10	74C90	1.85
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CD4069	35	74C161	2.30
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CD4071	35	74C164	2.39
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74LS00N	35	74LS164N	1.19
74LS01N	28	74LS165N	89
74LS02N	28	74LS166N	2.48
74LS03N	28	74LS168N	1.89
74LS04N	39	74LS169N	1.89
74LS05N	28	74LS170N	1.99
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74LS10N	28	74LS175N	99
74LS11N	39	74LS181N	2.20
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74LS13N	47	74LS191N	1.15
74LS14N	1.25	74LS192N	98
74LS15N	39	74LS193N	98
74LS20N	26	74LS194N	1.15
74LS21N	38	74LS195N	95
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74LS42N	79	74LS247N	1.10
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74LS51N	26	74LS251N	1.79
74LS54N	35	74LS253N	98
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74LS74N	59	74LS259N	2.95
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74LS78N	65	74LS266N	59
74LS83AN	99	74LS273N	1.75
74LS85N	1.19	74LS275N	4.40
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74LS107N	45	74LS324N	1.75
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74LS112N	49	74LS348N	1.95
74LS113N	49	74LS352N	1.65
74LS114N	55	74LS353N	1.65
74LS122N	55	74LS363N	1.49
74LS123N	1.19	74LS365N	99
74LS124N	1.35	74LS366N	99
74LS125N	89	74LS367N	99
74LS126N	89	74LS368N	99
74LS132N	79	74LS373N	2.75
74LS136N	59	74LS374N	2.75
74LS138N	89	74LS375N	69
74LS139N	89	74LS377N	1.95
74LS145N	1.25	74LS385N	1.95
74LS148N	1.49	74LS386N	65
74LS151N	79	74LS390N	1.95
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74LS155N	1.19	74LS399N	2.95
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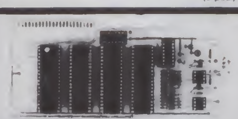

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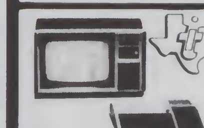

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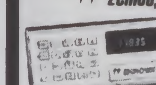

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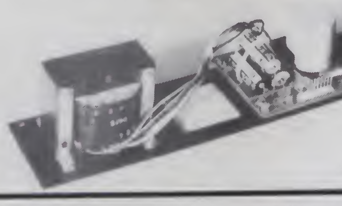

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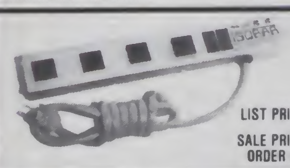

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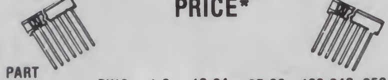
3 LEVEL GOLD WIRE WRAP SOCKETS PRICE*



PART NO.	PINS	1-9	10-24	25-99	100-249	250-999
RNS-08WWG	8	.50	.42	.40	.37	.33
RNS-14WWG	14	.60	.49	.47	.45	.42
RNS-16WWG	16	.65	.52	.50	.47	.44
RNS-18WWG	18	.85	.75	.70	.65	.60
RNS-20WWG	20	1.00	.90	.80	.75	.70
RNS-22WWG	22	1.25	1.15	1.10	1.05	1.00
RNS-24WWG	24	1.25	1.15	1.10	1.05	1.00
RNS-28WWG	28	1.60	1.50	1.40	1.30	1.20
RNS-40WWG	40	1.85	1.65	1.55	1.45	1.35

*Price based on gold not exceeding $400.00 per oz.

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2114-3L 1Kx4 300ns Low Power.	8 $45.00 100 + $4.50 ea.
5257-3L 4Kx1 300ns Low Power.	8/$55.00 100 + $5.25 ea.
2102AL-2 L/P 250ns in lots of 20.	1.25 ea. 100 + 1.10 ea.

RS232 and "D" SUB-MINIATURE CONNECTORS

P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
CND-DE9P	9 PIN MALE	$ 2.10	$ 1.90	$ 1.70
CND-DE9S	9 PIN FEMALE	$ 2.70	$ 2.40	$ 2.10
CND-DE9C	9 PIN COVER	$ 1.50	$ 1.25	$ 1.10
CND-DA15P	15 PIN MALE	$ 2.75	$ 2.45	$ 2.15
CND-DA15S	15 PIN FEMALE	$ 3.95	$ 3.60	$ 3.20
CND-DA15C	15 PIN COVER	$ 1.50	$ 1.30	$ 1.10
CNO-0B25P	25 PIN MALE	$ 3.50	$ 3.25	$ 3.00
CND-0B25S	25 PIN FEMALE	$ 4.60	$ 4.35	$ 4.20
CNO-0B51212	1 PC. GREY HOOD	$ 1.60	$ 1.45	$ 1.30
CNO-P25H	2 PC. GREY HOOO	$ 1.50	$ 1.25	$ 1.10
CND-0B51226	2 PC. BLACK HOOD	$ 1.90	$ 1.65	$ 1.45
CND-DC37P	37 PIN MALE	$ 5.80	$ 5.10	$ 4.45
CND-DC37S	37 PIN FEMALE	$ 8.70	$ 7.70	$ 6.70
CND-DC37C	37 PIN COVER	$ 1.80	$ 1.55	$ 1.30
CND-DD50P	50 PIN MALE	$ 8.75	$ 7.75	$ 6.70
CND-0D50S	50 PIN FEMALE	$11.65	$10.25	$ 8.90
CND-0D50C	50 PIN COVER	$ 2.00	$ 1.80	$ 1.60
CND-020418	HARDWARE SET 2 PR.	$ 1.00	$ 0.80	$ 0.70
CND-RS2328F	RS232, DB25P, EIA CLASS 1 CABLE 8 CON. 8 FT.	$19.95	$17.95	$15.95
CND-5730360	CENT. 700 SERIES PRINTER CONNECTOR	$ 9.00	$ 7.50	$ 6.00

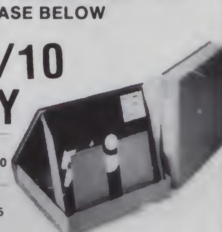
Verbatim

Part No.	Sectoring	Application	Pk. of 2	Box of 10
VRB MD 525-01	Soft Sector	TRS-80 Apple	$ 8.95	$29.95
VRB MD 525-10	Hard 10 Sector	North Star	$ 8.95	$29.95
VRB MD 525-16	Hard 16 Sector	Micropolis	$ 8.95	$29.95
VRB FD32-1000	Hard Sector	Shugart 801R	$11.95	$37.00
VRB-FD34-1000	Soft Sector	IBM 3740	$11.95	$37.00

SHIPPING WEIGHT 1 LB

BE SURE TO ORDER YOUR KASSETTE/10 LIBRARY CASE BELOW

KASETTE/10 LIBRARY



Part No		
MMM KS-10-	GREY BLACK BLUE BIEGE	8" DISKETTE HOLDER $4.50 or 3/$11.00
MMM KM 10-	GREY BLACK BLUE BEIGE	5¼" DISKETTE HOLDER $4.25 or 3/$10.00

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all ECONORAMS from COMPUKIT include:

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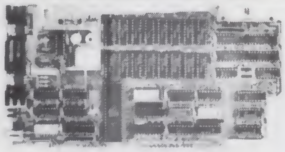
- 4 MHz with Z80 - 5 MHz with 8085
- Buffered tri-state outputs and buffered inputs.
- All lines buffered; address and data lines buffered to 1 low power Schottky TTL load, all other lines buffered to less than 1 TTL load.
- Onboard regulation.
- DIP switch address selection and deselection (no wire jumpers).
- Low power Schottky support ICs.
- S-100 boards have WRITE strobe selections switch - allows use of memory with or without front panel.
- All ICs are socketed (including support chips)
- Unique multi-block configurations for addressing flexibility.
- Industry standard board sizes.
- High quality, double sided, plate through, solder-masked and legended circuit board.
- LOW current consumption and guaranteed specs.
- 1 year limited warranty (not just 90 days).

SALE SALE

Most ECONORAMs come in 3 forms; UNKIT (UKT) - (this means that all sockets, disc capacitors are already soldered in place for easy assembly), fully assembled & tested (A&T), or qualified under the Certified System Component (CSC) high-reliability program (200 hour burn-in, guaranteed 4MHz operation over full temperature range, serial numbered, immediate replacement in event of failure with 1 year of invoice date).

NEW SPECTRUM S-100 COLOR GRAPHICS BOARD



Includes 8K of IEEE-compatible static RAM; full duplex bi-directional parallel I/O port for keyboard, joystick, etc. interface; and 6847-based graphics generator that can display all 64 ASCII characters. 10 modes of operation, from alphanumeric/semi-graphics in 8 colors to ultra-dense 256 x 192 full graphics. 75 Ohm RS-170 line output and video output for use with FCC approved modulators. **Introductory prices:**

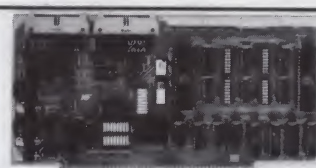
	Reg.	Sale
GBT-144 KIT	**$339.00**	**$319.00**
GBT-144 A (Assembled)	**$399.00**	**$349.00**

Don't settle for black and white graphics or stripped-down color boards; specify the CompuPro Spectrum.

Want graphics software? Sublogic's 2D Universal Graphics Interpreter (normally $35) **is yours for $25 with any Spectrum board purchase.**

GBT-2D $25.00

CK022 S-100 INTERFACER



Our new I/O board gives you unparalleled flexibility and operating convenience. We include such features as:

- 2 independently addressable serial ports (dip switch selectable addresses)
- Real LSI hardware UARTs for minimum CPU housekeeping
- RS232C, current loop (20mA), & TTL signals on both ports
- Precision, crystal-controlled Baud rates up to 19.2K Baud (individually dip switch selectable)
- Transmit & receive interrupts on both channels, jumperable to any vectored interrupt line
- Industry standard RS232 level converters with five RS232 handshaking lines per port
- Optically isolated current loop with provisions for both on-board & off-board current sources
- UART parameters, interrupt enables & RS232 handshaking lines are software programmable with power-on hardware default to customer specified hard-wired settings for maximum flexibility
- Port connectors mate directly to ribbon cable & DB25 connectors in standard pinouts
- RS232 lines will conform to either master or slave configurations
- Board gives full feature operation with both 2 & 4 MHz systems
- Low power consumption; +8V @ 450mA; +16V @ 150mA; –16V @ 70mA max.
- No software initialization required for board operation, although board parameters may be altered by software 2 lbs.

	Reg.	Sale
GBT - INTERFACER I UKT	**$199.00**	**$189.00**
GBT - INTERFACER I A&T	**$249.00**	**$219.00**

NEW! 32K X 8 ECONORAM XX

Static Storage for the S-100 buss

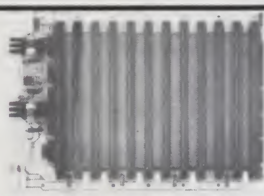
32K BANK SELECT! S-100 compatible 5 MHz guaranteed operation (0-70 c). Features 1 x 32K block positionable on any 4K boundry. Windows may be positioned every 4K. Bank Select port may be any one of 256 I/O Ports, and any data bit maybe used as a control bit. Perfect for use on Alpha Micro Systems, Marinchip, Cromemco, and others with IEEE 24 Bit extended addressing. Uses 4K x 1 low power STATIC rams. Current consumption guaranteed 3500 MA max. Shipping Weight 2 lbs.

	Reg.	Sale
GBT-2016 UKT 16K UNKIT	**$349.00**	**$329.00**
GBT-2016 AT 16 A&T	**$419.00**	**$369.00**
GBT-2024 UKT 24K UNKIT	**$479.00**	**$449.00**
GBT-2024 AT 24K A&T	**$539.00**	**$479.00**
GBT-2032 UKT 32K UNKIT	**$649.00**	**$598.00**
GBT-2032 AT 32K A&T	**$729.00**	**$649.00**

INTERFACER II

The new Interfacer II I/O board incorporates one channel of serial I/O with all the features of the INTERFACER dual RS232 serial board, plus 3 full duplex Parallel ports. The serial section includes all the features you've come to expect - a hardware UART, on-board crystal controlled Buad rate generator, hardware/software programmability, RS232 handshaking lines with real RS232 drivers, current loop & TTL drivers, full interrupts and more!!! The parallel selection utilizes LSTTL octal latches for latched input & output data with 24mA drive current, attention, enable & strobe bits for each parallel port (each with selectable polarity), interrupts for each input port, separate 25 pin connectors with power for each channel and a status port for interrupt mask and port status. All in all - an incredibly flexible and easy to use board.

	Reg.	Sale
GBT - INTERFACER II UKT	**$199.00**	**$189.00**
GBT - INTERFACER II A&T	**$249.00**	**$219.00**



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MOTHERBOARDS

A Must for Reliable System Operation!!!

NEW

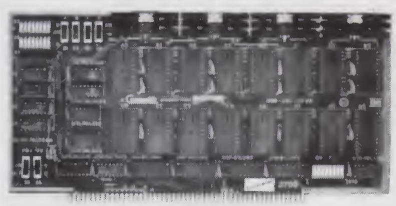
These are third generation micro-motherboards set up to exceed the latest S-100 specs. Designed with operation of the newest 5 to 10 MHz MPUs in mind — with any of these motherboards, you won't have to start from scratch when you want to upgrade your system from 2 or 4 MHz operation.

True active termination — with split termination — half of the termination load at each end of every buss line. Grounded Faraday shield between all buss signal lines to minimize cross-talk. Heavy duty power traces for minimal power loss. Power connectors supplied. All edge connectors & termination resistors supplied soldered to board in "UNKIT" versions. All sizes fit Godbout, Vector, IMSAI, TEI, etc. enclosures.

All boards are double sided fiberglass epoxy, G10/FR4, with plated through holes & solder mask on both sides. A parts legend on the component side makes assembly a snap.

	Reg.	Sale
GBT-CK024 UK 19 SLOT UNKIT	**$174.00**	**$159.00**
GBT-CK024 AT 19 SLOT A&T	**$214.00**	**$189.00**
GBT-CK025 UK 12 SLOT UNKIT	**$129.00**	**$119.00**
GBT-CK025 AT 12 SLOT A&T	**$169.00**	**$149.00**
GBT-CK026 UK 6 SLOT UNKIT	**$ 89.00**	**$ 79.95**
GBT-CK026 AT 6 SLOT A&T	**$129.00**	**$119.00**

ECONOROM 2708



Has provisions for wait states for 4MHz operations. Configured as four 4K blocks - each independently addressable and disableable. Power-on jump. Does **NOT** include 2708s. Includes all support chips, sockets, regulators, heat sinks, etc. Sold in UNKIT form **only.** Shipping Weight 2 lbs.

GBT - ECONOROM 2708 UKT **$85.00**

NEW NEW NEW NEW

	Reg.	Sale
GBT-SPECTRUM (Color graphics) KIT	339.00	319.00
GBT-SPECTRUM (Color graphics) A&T	399.00	349.00
GBT-CPU-Z80 KIT	225.00	210.00
GBT-CPU-Z80 A&T	295.00	269.00
GBT-CPU-8085 KIT	235.00	220.00
GBT-CPU-8085 A&T	325.00	259.00
GBT-CPU-8085/8088 KIT	385.00	365.00
GBT-CPU-8085/8088 A&T	495.00	449.00
GBT-BOX-DESK (S-100 Mainframe)	289.00	269.00
GBT-BOX-RACK (S-100 Mainframe)	329.00	309.00

ECONORAM XIV

16K x 8 for S-100. Addressable on any 4K boundary. Direct addressing on up to 24 address lines. Fully meets IEEE S-100 buss. specs. Low power, hi speed static memory. Operates up to 5MHz with newest 8085/8086/8088 CPUs. Can be used with 8080, Z80, 8085, 8086, 8088, Z8000, etc.

	Reg.	Sale
GBT - ECONORAM XIV UKT	**$299.00**	**$279.00**
GBT - ECONORAM XIV A&T	**$349.00**	**$298.00**

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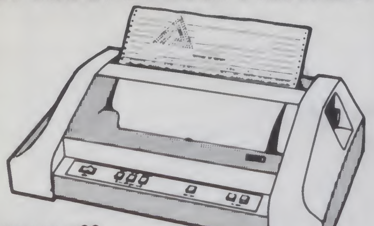
ANADEX DP9500/DP9501 PRINTERS



$1650.00

New from Anadex! Two low cost, high performance printers designed for all applications, including standard high-density graphics capability. Both models feature a 9 wire print head with an incredible life expectancy of 650 million printed characters! Full 96 character ASCII set with lower case descenders, double width printing, bi-directional with shortest distance sensing logic. Adjustable-width tractor feed, forms control, horizontal and vertical tabbing, and print up to five copies. Easy interfacing with parallel, RS-232 serial or current loop choices.

The DP9500 is the choice when you require mostly printing and occasional graphics. Select between a 9 x 9 character font and 132 columns, or a 7 x 9 font for 175 columns. Printer speed 150/200 CPS. Wt 35 lbs.

The DP9501 is mainly for graphics applications. The 11 x 9 character font produces superb graphics reproduction in 132 columns, and the 7 x 9 character font in 220 columns provides maximum graphics potential. Both models operate at 110VAC, and 220 VAC for European use. Wt 35 lbs.

Cat No. 2551 DP9500 printer
Cat No. 2552 DP9501 printer

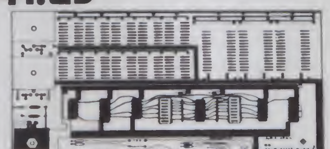
74LS Order by Cat No. 999 and Type

74LS00	$ .33	74LS74	$ .99	74LS161	$3.75	74LS257	$ .99
74LS01	$ .29	74LS75	$ .59	74LS162	$1.19	74LS258	$ .66
74LS02	$ .49	74LS76	$ .44	74LS163	$1.15	74LS259	$1.99
74LS03	$ .29	74LS83	$ .88	74LS164	$1.15	74LS260	$ .66
74LS04	$ .49	74LS85	$1.15	74LS165	$1.69	74LS261	$2.50
74LS05	$ .35	74LS86	$ .99	74LS166	$3.95	74LS266	$ .66
74LS08	$ .44	74LS90	$ .59	74LS168	$1.29	74LS273	$3.25
74LS09	$ .29	74LS92	$ .75	74LS169	$3.33	74LS275	$4.95
74LS10	$ .44	74LS93	$ .75	74LS170	$2.25	74LS279	$ .49
74LS11	$ .29	74LS95	$ .88	74LS173	$1.25	74LS283	$1.75
74LS12	$ .29	74LS107	$ .55	74LS174	$1.10	74LS293	$1.99
74LS13	$ .55	74LS109	$ .55	74LS175	$ .99	74LS295	$1.99
74LS14	$1.10	74LS112	$ .55	74LS181	$2.50	74LS298	$1.10
74LS15	$ .35	74LS113	$ .55	74LS190	$ .69	74LS324	$1.75
74LS20	$ .29	74LS114	$ .55	74LS191	$1.15	74LS365	$ .99
74LS21	$ .39	74LS122	$ .55	74LS192	$ .99	74LS366	$ .89
74LS22	$ .29	74LS123	$1.15	74LS193	$1.15	74LS367	$ .99
74LS26	$ .77	74LS124	$1.55	74LS194	$1.15	74LS368	$ .99
74LS27	$ .55	74LS125	$ .88	74LS195	$1.15	74LS373	$3.25
74LS28	$ .44	74LS126	$ .88	74LS196	$ .99	74LS374	$4.50
74LS30	$ .39	74LS132	$ .88	74LS197	$1.99	74LS377	$3.25
74LS32	$ .66	74LS138	$1.25	74LS221	$1.99	74LS378	$1.69
74LS33	$ .69	74LS139	$ .99	74LS240	$3.95	74LS386	$ .77
74LS37	$ .39	74LS145	$1.99	74LS241	$2.95	74LS393	$2.25
74LS38	$ .59	74LS147	$2.95	74LS242	$1.95	74LS395	$1.99
74LS40	$ .33	74LS151	$ .88	74LS243	$2.95	74LS399	$2.95
74LS42	$ .88	74LS153	$ .88	74LS244	$3.25	74LS424	$3.25
74LS47	$ .88	74LS154	$3.50	74LS245	$5.00	74LS670	$2.25
74LS48	$ .88	74LS155	$ .99	74LS247	$ .88	81LS95	$1.95
74LS51	$ .39	74LS156	$1.25	74LS248	$ .99	81LS96	$1.95
74LS54	$ .29	74LS157	$1.25	74LS251	$1.99	81LS97	$1.95
74LS55	$ .55	74LS158	$1.49	74LS253	$ .99	81LS98	$1.95
74LS73	$ .44	74LS160	$ .99	74LS256	$2.25		

TTL's Order by Cat No. 999 and Type

7400	$.35	7445	$ .77	74109	$ .55	74176	$ .79
7401	$.35	7446	$ .69	74116	$1.89	74177	$ .77
7402	$.35	7447	$ .66	74120	$ .99	74179	$1.88
7404	$.44	7448	$ .77	74121	$ .44	74180	$ .77
7405	$.44	7450	$ .20	74122	$ .50	74181	$1.88
7406	$.39	7451	$ .50	74123	$ .52	74182	$1.99
7407	$.39	7453	$ .50	74125	$ .52	74184	$1.99
7408	$.35	7454	$ .20	74126	$ .49	74185	$1.99
7409	$.35	7460	$ .29	74132	$ .69	74190	$1.19
7410	$.35	7470	$ .29	74141	$ .77	74191	$1.19
7411	$.39	7472	$ .29	74143	$3.33	74192	$ .77
7412	$.49	7473	$ .36	74145	$7.77	74193	$ .89
7413	$.44	7474	$ .49	74148	$1.29	74195	$ .69
7414	$.66	7475	$ .49	74150	$ .88	74196	$ .88
7416	$.45	7476	$ .38	74151	$ .59	74197	$ .88
7417	$.29	7479	$3.99	74153	$ .69	74198	$1.49
7420	$.35	7480	$ .50	74155	$ .49	74199	$1.49
7422	$.44	7481	$ .99	74156	$ .99	74221	$1.99
7423	$.44	7483	$ .59	74157	$ .63	74251	$ .77
7425	$.38	7485	$ .85	74160	$ .77	74273	$1.10
7426	$.39	7486	$ .35	74161	$ .79	74278	$2.95
7427	$.35	7489	$1.66	74162	$ .79	74279	$ .82
7430	$.35	7490	$ .44	74163	$ .88	74365	$ .69
7432	$.39	7491	$ .59	74164	$ .88	74366	$ .69
7437	$.39	7492	$ .45	74165	$ .88	74367	$ .69
8438	$.39	7493	$ .45	74166	$1.29	74368	$ .69
7440	$.20	7495	$ .65	74170	$1.59	74393	$2.50
7441	$.77	7496	$ .65	74173	$1.09	8T26	$2.50
7442	$.49	74100	$1.69	74174	$ .79	8T97	$2.25
7433	$.69	74107	$ .44	74175	$ .79		

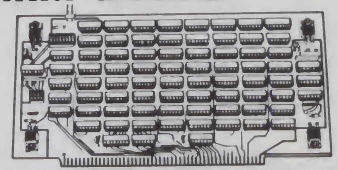
SSM OB1 VECTOR JUMP & PROTOTYPING CARD $41.25*



Plug compatible for S-100 bus systems, features full 16 bit vector jump address with dip selection of 8080 or Z80. Can be set to jump on power-on-clear, reset, or both. Prototyping areas on the card for ten 16-pin IC's three 24-28 pin IC's and two spare regulator patterns.

*Cat No. 1429	OB1 kit	$41.25
Cat No. 1430	OB1 a & t	$85.00
Cat No. 1431	OB1 bareboard	$32.00

SSM MB6B 8K STATIC RAM BOARD



8K bytes by 8 bits, fully buffered, compatible with 8080, 8085, and Z80. Dip switch addressing of independant 4K halves lets the MB6B think like two 4K boards, or one 8K board. Independent 4K addressing allows the flexibility to meet varying software memory needs. Uses low power 21L02 RAM's, operates at 2 or 4MHZ, and is compatible with direct memory access controllers.

Cat No.	Description	Price
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*1400-B	250ns kit	$147.50
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Cat No. 2584 TRS-80 L2, 16K, cassette

GALACTIC TRADER

Gives you the opportunity to be a big time wheeler dealer. You will seek out the origins of various commodities, and buy cheap. You may then sell them at exhorbitant rates or barter for local goods. Your good business sense and level head allow you to out-think the sharpest business creatures in the galaxy! Ten levels of difficulty allow you to increase your skill without out growing the game.

Cat No. 2585 TRS-80 L2, 16K, cassette

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In the final game of this galactic trilogy, you will be a diplomat and administrator of unequalled accomplishments. Your prowess at manipulation will decide if various power groups will be swayed to your side, and your military leadership will put the finishing touches on a successful revolution.

Cat No. 2586 TRS-80 L2, 16K, cassette

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All 3 for $29.95

SOUNDING BOARD for Apple II

Enter the world of microcomputer music and sounds! One board will turn your apple into a fine musical instrument and, in addition, produce sound effects which will spice up any program. Each board has three programmable voices, and on-board generator and built-in amplifier which can drive an 8 ohm speaker. The Sounding Board has a five octave range starting at 55hz which is (a) below the bass clef, to 1760hz which is 2 octaves above the treble clef. The apple will hold 6 boards which would give you the capacity to create 18 simultaneously programmable voices. Music can be composed, edited, played and then stored. Musical notes can be entered directly from the keyboard. included with your board is an interactive music editor, sample music, and a demonstration program which plays continuous music. Wt 3 oz.

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NEWDOS + TRS-80 DOS

Contains the following: NEWDOS provides fixes for many of TRSDOS 2.1's problems. Enhancements to BASIC include built-in renumbering, some abbreviated commands, scrolling of listings up or down, screen printing, clears up keyboard bounce, append now works, direct call to DOS without leaving BASIC, and display of all variables used; DIRCHECK tests and lists disk directories; DISASSEM, which is a disassembler; EDTASM allows the use of the Radio Shack Editor-Assembler on disk with disk I/O Level 1 in Level 2. This allows you to use or create Level 1 programs and also save or retrieve them from disk using LVIDSKSL; LMOFFSET helps save and load machine language tapes from disk, even if in the same memory as DOS; SUPERZAP allows you to display, print, and modify disks or memory. Complete with extensive documentation, requires TRSDOS and the Radio Shack Editor-Assembler.

Cat No. 1549 TRS-80 L2, 16K w/disk **$99.00**

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In addition to being a challenging and innovative game, Pirates Cove is designed so that different adventures can be created by changing the data base. While playing the game you wander thru various rooms and, by manipulating the objects, you try to find the hidden "treasures". You may have to defeat a wild animal to get to the treasure, or figure out how to get it out of the bog. A game in progress may be saved on tape and used later.

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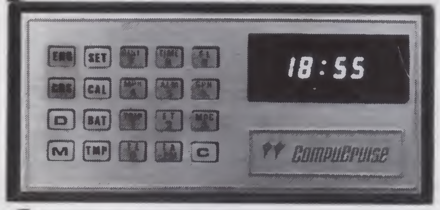

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COMPU CRUISE CHART

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2 Current fuel eff/L/100	X	X	X
3 Av fuel eff/trip mpg	X	X	X
4 Av fuel eff/trip/L100Km	X	X	X
5 Fuel used since fillup/gal	X	X	X
6 Fuel used since fillup/L	X	X	X
7 Distance since fillup	X	X	X
8 Distance since fillup/Km	X	X	X
9 Time of day	X	X	X
10 Time to empty	X	X	X
11 Distance to empty/miles	X	X	X
12. Distance to empty/Km	X	X	X
13 Fuel to empty/gal	X	X	X
14 Fuel to empty/L	X	X	X
15. Current vehicle speed/mph	X	X	X
16 Current vehicle speed/Km/h	X	X	X
17 Av vehicle speed/mph	X	X	X
18 Av vehicle speed/Km/H	X	X	X
19 Night time display/dimming	X	X	X
20. Error display	X	X	X
21. Elapsed time hrs/min/sec			
22 Trip driving time	X	X	X
23 Time to arrival	X	X	
24 Alarm	X	X	
25 Distance traveled on trip/mi	X	X	X
26. Distance traveled on trip/Km	X	X	X
27. Distance to arrival/mi	X	X	
28 Distance to arrival/Km	X	X	
29 Fuel used on trip/gal	X	X	X
30. Fuel used on trip/L	X	X	X
31. Fuel to arrival/gal	X	X	
32. Fuel to arrival/L	X	X	
33. Current fuel consumption/gph	X	X	
34 Current fuel consumption/Lph	X	X	
35 Av fuel consumption/gph	X	X	
36 Av fuel consumption/Lph	X	X	
37. Inside temp/F	X	X	
38 Inside temp/C	X	X	
39 Outside temp/F	X	X	
40 Outside temp/C	X	X	
41 Battery voltage	X	X	
42. Cruise control set	X		
43 Cruise control resume	X		
44 Cruise control program	X		

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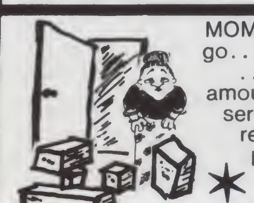

MOM's cleaning house . . . these items must go . . . prices listed are last advertised prices . . . MAKE OFFER . . . any reasonable amount will be accepted . . . first come, first serve . . . now's your chance to get some really great savings . . . you name the price . . . hurry supplies are limited.

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COMPUPRO S-100 MOTHERBOARDS: DESIGNED FOR THE FUTURE, AVAILABLE NOW

Specifically designed to handle the new generation of 5 to 10 MHz CPUs coming on line (as well as present day 2 and 4 MHz systems), these advanced motherboards feature Faraday shielding between all bus signal lines to minimize crosstalk, active termination that splits the termination load between each end of every bus line, and mechanical compatibility with Godbout, Vector, Imsai, TEI, and similar enclosures. Available in "unkit" form (edge connectors and termination resistors pre-soldered in place for easy assembly), or fully assembled and ready to go.

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NOTE: Most **CompuPro** boards are available in **unkit** form (sockets, bypass caps pre-soldered in place), **assembled**, or qualified under the **Certified System Component** (CSC) high-reliability program (200 hour burn-in, more).

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74LS20	28	74LS170	195
74LS21	38	74LS174	90
74LS22	38	74LS175	90
74LS26	39	74LS190	110
74LS27	36	74LS193	95
74LS30	26	74LS195	95
74LS32	39	74LS196	85
74LS38	39	74LS221	140
74LS42	78	74LS240	245
74LS48	78	74LS241	245
74LS51	25	74LS243	220
74LS54	35	74LS244	245
74LS74	52	74LS245	695
74LS75	65	74LS253	95
74LS83	95	74LS257	95
74LS85	115	74LS258	95
74LS86	45	74LS259	285
74LS90	70	74LS279	55
74LS93	70	74LS283	100
74LS107	45	74LS293	185
74LS112	48	74LS298	120
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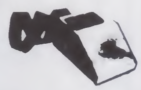

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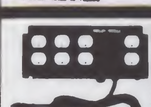

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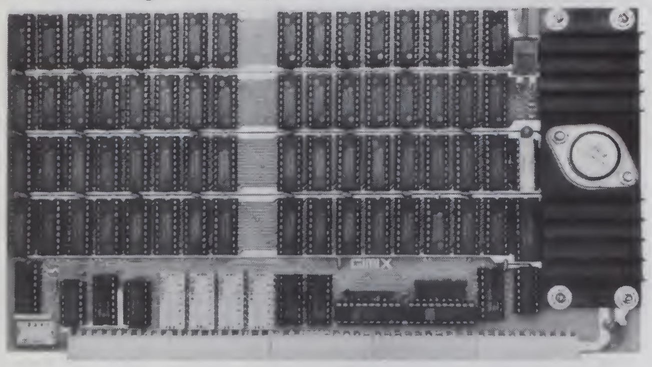

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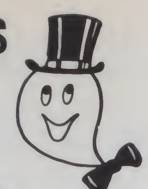

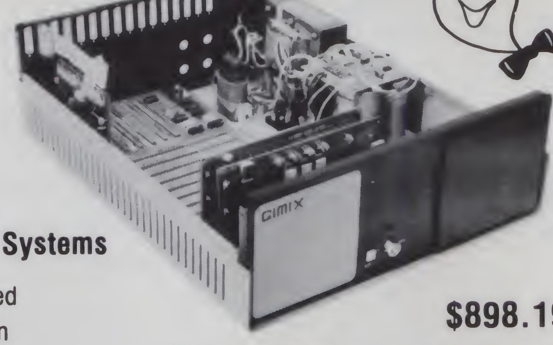

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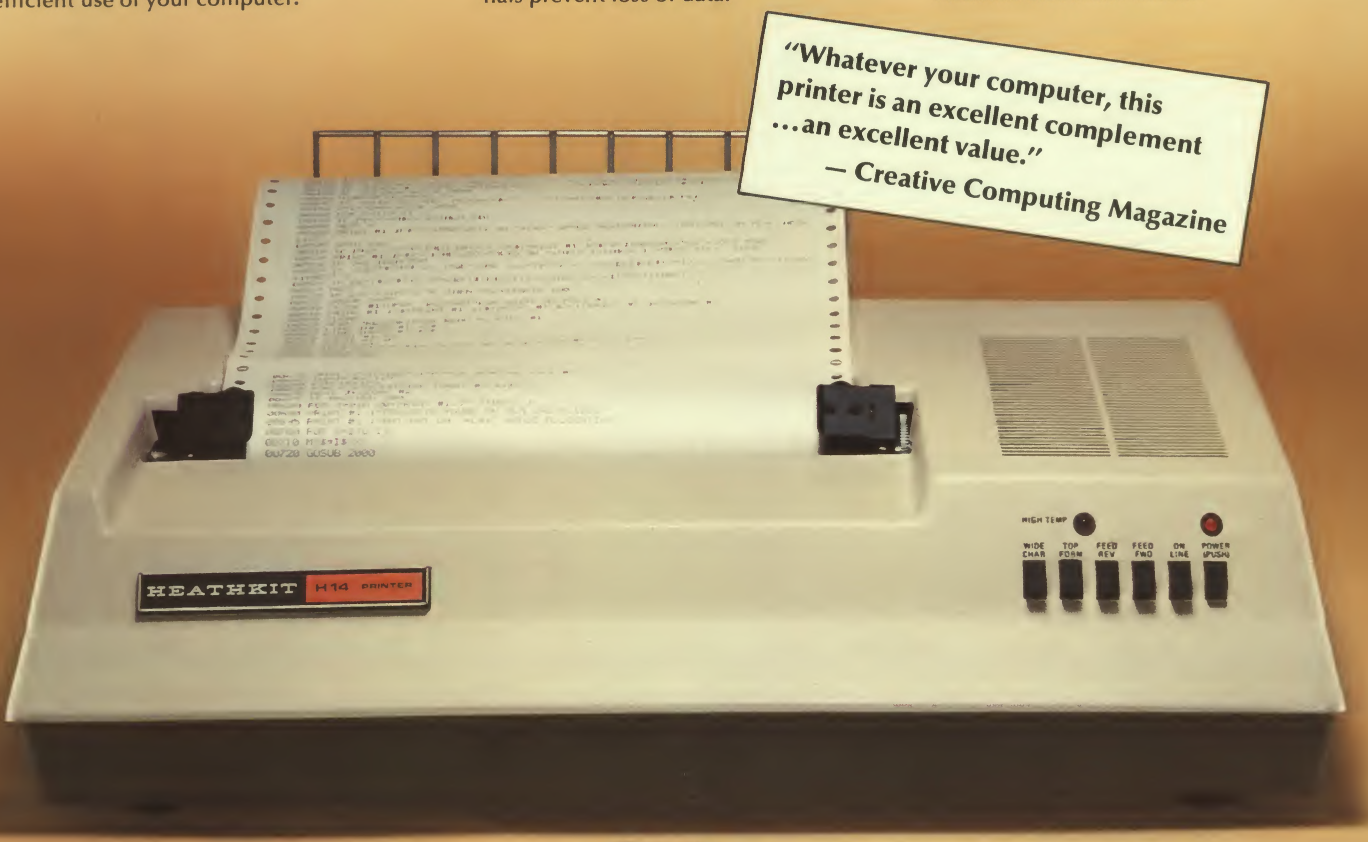

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CP-180

Ohio Scientific: The leader in Winchester based micro-computers.

Ohio Scientific produced the first large capacity fixed media hard disk (Winchester) based microcomputers in 1977. Since then we have shipped more of these systems than the rest of the microcomputer industry combined.

Family Features

All standard C3 features including:

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- 48K static RAM
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- Slide-mounted subassemblies, removable side panels and locking rear door for easy expansions and service.

C3-A

The floppy only rack based C3 for users who anticipate expansion to hard disk, multi-user and/or networking in the future. **Under $7000.**

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The world's most powerful microcomputer (when GT equipped). Features the highly advanced and extensively field proven OKIDATA 3306 Winchester disk.

Features

- System boots from floppies or hard disk on power up
- 74 megabytes end user workspace under OS-65U, 80 megabytes unformatted
- Ultra-high performance disk
  74 millisec worst case access
  38 millisec average
  10 millisec access on cylinder (215K user workspace)
  8 megabits per second transfer rate
- Simple on/off disk operation with elaborate internal protection from improper temperature, line voltage and controller failures
- Features spindle brake and designated head landing areas for much longer operational life than the newer low-cost Winchesters
- Highly advanced OS-65U operating system:
  Multiple level pass word security
  Multiple operating systems on disk
  Ultra-high speed "FIND" command for high speed string searches (Associative Access)
  Upward compatible with multi-user and network systems with full file, peripheral and communications arbitration between users
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A medium performance Winchester disk based system which provides the ideal cost/performance ratio in typical small business applications. The C3-C uses the Shugart SA4008 29 megabyte Winchester disk.

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- 29 megabytes unformatted capacity
- Medium performance Winchester
  240 millisec worst case access
  87 millisec average access
  10 millisec access on cylinder (110K user workspace)
- Simple on/off disk operation **Under $11,000**

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